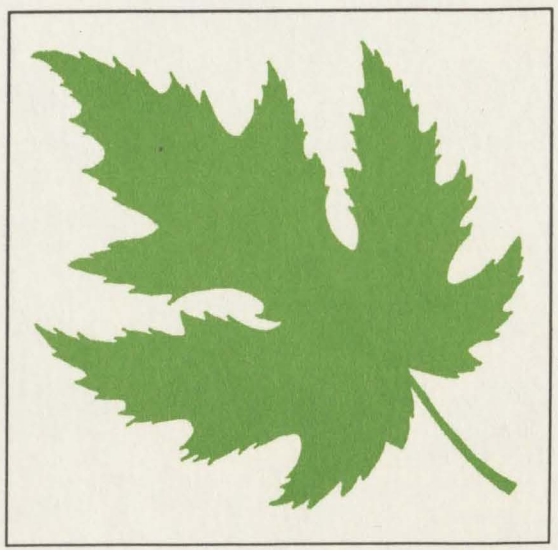
COURSES ON THE ENVIRONMENT

A Student Guide to University of Minnesota

Courses on Environmental Issues on the Twin Cities Campus



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CONTENTS

GENERAL INFORMATION

Courses on the Environment is intended to be a guide for faculty and students and is supplemental to official University bulletins of the various centers, colleges, and institutes of the University of Minnesota.

In the broadest sense, a very large number of courses and programs at the University have implications for environmental quality. It was necessary, however, to set some limits on what would be included in the student guide. There is no environmental studies department at the University and no formal undergraduate degree program in environmental studies. However, there are programs in the College of Liberal Arts and University College in which students can design their own environmental studies major. For information about CLA's special learning opportunities and individualized programs contact the Office for Special Learning Opportunities, 220 Johnston Hall (624-7577). For information about UC's degree programs contact the Inter-College Program, 7 Wulling Hall (624-2004), or the University College Program for Individualized Learning, 201 Wesbrook Hall (624-4020).

Part I of this guide provides a subject index which is designed to aid students interested in pursuing an interdisciplinary area of environmental study. While some courses are obviously found in a certain department, it is frequently difficult for students interested in a particular environmental problem to be aware of all the courses available throughout the various collegiate units which pertain to their particular area of interest. For example, courses dealing with various aspects of energy or land use are found in several departments and described in various University bulletins. The subject index identifies such topical areas and steers interested students to the appropriate courses in various colleges and departments. All courses listed in Part I are described in Part II.

Part II of this guide provides environmental course descriptions according to department headings and, in most instances, the name of an individual who is prepared to advise students desiring more information about environmental courses. Several collegiate units offer, through their departments, degree programs that include a primary concentration on environmental studies. Part II is designed to serve as a guide to students pursuing an environmental studies emphasis within a given departmental major or minor. Students interested in exploring the full extent of degree programs and course offerings in a specific department should consult the appropriate college bulletin. Part III of this guide provides a listing of special centers, services, and libraries. The special centers and services section lists organizations in the Twin Cities that participate in environmentally related activities and are frequently engaged in research and other projects in which interested students, faculty members, and others might become involved. Although these various centers do not offer classes, in some cases students may obtain credit for work completed in such outside activities. The libraries section lists Twin Cities libraries that have collections with an environmentally related emphasis.

COURSE ABBREVIATIONS AND SYMBOLS

Departmental prefix: Abbreviation indicating name of department (e.g., Geog for Geography).

Course Number: Four-digit figure denoting the course (e.g., 5002).

† All courses preceding this sign must be completed before credit will be granted for any quarter of the sequence.

§ Credit will not be granted if equivalent course listed after this symbol has been taken for credit.

¶ Concurrent registration allowed with course listed after this mark.

Consent of instructor is required for registration.

Δ Consent of department offering the course is required for registration.

H Honors course.

f,w,s,su Following a course number indicate fall, winter, spring, or summer quarters.

PART I. COURSES LISTED BY SUBJECT AREA

BIOLOGICAL PEST AND DISEASE CONTROL

Ecology and Behavioral Biology (EBB)

5116. INTRODUCTION TO ANIMAL PARASITOLOGY.

Entomology (Ent)

1005. ECONOMIC ENTOMOLOGY.
5210. INTEGRATED PEST MANAGEMENT.
5250. FOREST ENTOMOLOGY.
5610. AQUATIC ENTOMOLOGY.
8240. COLLOQUIUM IN INSECT ECOLOGY.
5280. LIVESTOCK ENTOMOLOGY.

Plant Pathology (PlPa)

1001. INTRODUCTORY PLANT PATHOLOGY.
5002. INTRODUCTORY PLANT PATHOLOGY FOR ADVANCED STUDENTS.
5007. AIR POLLUTION AND OTHER ABIOTIC CAUSES OF PLANT DISEASE.
5008. INTRODUCTION TO PLANT NEMATOLOGY.
5050. FOREST PATHOLOGY.
8003. PLANT DISEASE THEORY III, POPULATIONS.

CULTURE, SOCIETY, AND ENVIRONMENTAL PROBLEMS

Anthropology (Anth)

5116. CULTURAL ECOLOGY.
5117. ENERGY, RESOURCE USE, AND SYSTEM CHANGE.

Architecture (Arch)

3001. ENVIRONMENTAL DESIGN: THEORY AND PROCESS.
3002. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT.
3060. TECHNOS: FORCE, FORM AND ARCHITECTURE.

Biology (Biol)

1101. HEREDITY AND HUMAN SOCIETY.

Business, Government, and Society (BGS)

3002. BUSINESS AND SOCIETY.

History of Science and Technology (HSci)

5311. TECHNOLOGY IN AMERICAN LIFE AND THOUGHT.

Humanities (Hum)

3663. IDEAS OF NATURE: ENGLAND AND AMERICA TO 1875.

Landscape Architecture (LA)

1021. HISTORY OF ENVIRONMENTAL DEVELOPMENT: ARCHITECTURE.
1022. HISTORY OF ENVIRONMENTAL DEVELOPMENT: LANDSCAPE ARCHITECTURE.
1023. HISTORY OF ENVIRONMENTAL DEVELOPMENT: PLANNING.
3001. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT.
3002. ENVIRONMENTAL DESIGN: TOOLS AND PROCESSES.
8330. CONCEPTS OF LANDSCAPE EVALUATION.

Political Science (Pol)

3970. ETHICS AND THE ENVIRONMENT.

Rhetoric (Rhet)

1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE.

Sociology (Soc)

3551. WORLD POPULATION PROBLEMS.

EARTH SCIENCES

Forest Resources (FR)

5262. REMOTE SENSING OF NATURAL RESOURCES.

Geography (Geog)

1401. PHYSICAL GEOGRAPHY.
3441. LANDFORM GEOGRAPHY.

Geology and Geophysics (Geo)

1001. PHYSICAL GEOLOGY.
1012. INTRODUCTION TO COMPARATIVE PLANETOLOGY.
1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA.
1111. INTRODUCTORY PHYSICAL GEOLOGY.
1601. OCEANOGRAPHY.
3401. INTRODUCTORY MINERALOGY.
5004. MINERALOGY.
5108. ADVANCED ENVIRONMENTAL GEOLOGY.
5201. STRUCTURAL GEOLOGY.
5251. GEOMORPHOLOGY.
5261. GLACIAL GEOLOGY.
8611. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA.

ENERGY USE

Architecture (Arch)

3064, 3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.

Civil Engineering (CE)

5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION.

Geology (Geo)

1005. GEOLOGIC PERSPECTIVES ON ENERGY.

Mechanical Engineering (ME)

5712. SOLAR ENERGY UTILIZATION.

Public Affairs (PA)

5711. ENERGY POLICY I.
5712. ENERGY POLICY II.

ENVIRONMENT, TECHNOLOGY, AND PUBLIC POLICY

Biology (Biol)

3051. BIOLOGY AND THE FUTURE OF MAN.
3052. ENVIRONMENTAL HEALTH AND TOXICOLOGY.
5951. SOCIAL USES OF BIOLOGY.

Business, Government, and Society (BGS)

3003. BUSINESS AND THE NATURAL ENVIRONMENT.
3019. MANAGEMENT AND THE NATIONAL ENVIRONMENT: ISSUES FOR INTERNATIONAL BUSINESS.
8055. BUSINESS, GOVERNMENT, AND MACROECONOMICS.
8202. EXTERNAL AFFAIRS MANAGEMENT.

Civil Engineering (CE)

5580. INTRODUCTION TO ENVIRONMENTAL LAW FOR ENGINEERS.
5581. ENVIRONMENTAL LAW.

Institute of Technology (IT)

3101. INDUSTRIAL SOLID WASTE CHARACTERIZATION AND RECOVERY.

Interdepartmental Study (ID)

3970. DIRECTED STUDIES.

Journalism (Jour)

5133. INTERPRETIVE REPORTING ABOUT SCIENCE.
5143. INTERPRETATION OF SCIENCE AND TECHNOLOGY.

Law (Law)

5215. ENVIRONMENTAL LAW.

Management (Mgmt)

8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES.

Mechanical Engineering (ME)

5402. ECOLOGY, TECHNOLOGY, AND SOCIETY.

Political Science (Pol)

3321. ISSUES IN AMERICAN PUBLIC POLICY.
3970. ETHICS AND THE ENVIRONMENT.
5523. THE POLITICS OF THE REGULATORY PROCESS.

Public Affairs (PA)

5701, 5702. TECHNOLOGY PLANNING I AND II.
5721. ENVIRONMENTAL POLICY I.
5722. ENVIRONMENTAL POLICY II.
8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Resource and Community Development (RCD)

1010. ISSUES IN THE ENVIRONMENT.

Soil Science (Soil)

1020. THE SOIL RESOURCE.

ENVIRONMENTAL HEALTH AND POLLUTION CONTROL

Biology (Biol)

3052. ENVIRONMENTAL HEALTH AND TOXICOLOGY.

Civil Engineering (CE)

5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.
5515. WATER AND WASTEWATER MICROBIOLOGY.
5530. MODELING AND PROCESS CONTROL OF WATER AND WASTEWATER TREATMENT.
5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING.

Ecology and Behavioral Biology (EBB)

5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION.

Environmental Health (PubH)

5151. ENVIRONMENTAL HEALTH.
5152. ENVIRONMENTAL HEALTH.
5158. HEALTH RISK EVALUATION.
5171. ENVIRONMENTAL MICROBIOLOGY.
5177. PUBLIC HEALTH BIOLOGY.
5181. AIR POLLUTION.
5184. AIR ANALYSIS.
5186. ENVIRONMENTAL CHEMISTRY.
5201. RADIATION PROTECTION AND MEASUREMENT.
5202. RADIATION PROTECTION AND MEASUREMENT LABORATORY.
5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT.
5261. GENERAL ENVIRONMENTAL TOXICOLOGY.

Institute of Technology (IT)

3101. INDUSTRIAL SOLID WASTE CHARACTERIZATION AND RECOVERY.

Mechanical Engineering (ME)

5609. AIR POLLUTION.
5612. ENVIRONMENTAL ENGINEERING.

FISH AND WILDLIFE

Ecology and Behavioral Biology (EBB)

5136. ICHTHYOLOGY.
5606. ECOLOGY OF FISHES.
5815. FIELD ETHOLOGY.
5817. VERTEBRATE ECOLOGY.
5834. FIELD ORNITHOLOGY.

Fisheries and Wildlife (FW)

1001. ORIENTATION IN FISHERIES AND WILDLIFE.
1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
3052. INTRODUCTION TO FISHERIES AND WILDLIFE BIOLOGY AND MANAGEMENT.
3167. TECHNIQUES OF FOREST WILDLIFE MANAGEMENT.
3600. FISHERIES AND WILDLIFE FIELD TECHNIQUES.
5129. MAMMALOGY.
5455. AQUACULTURE.
5459. ENVIRONMENTAL PHYSIOLOGY OF FISHES.
5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS.
5603. WILDLIFE HABITAT RELATIONSHIPS AND MANAGEMENT.
5604. FISHERY MANAGEMENT IN INLAND WATERS.

Veterinary Biology (VB)

5330. WILD BIRD MEDICINE.

FOREST MANAGEMENT

Forest Resources (FR)

1200. INTRODUCTION TO FOREST RESOURCES.
1202. FARM AND SMALL WOODLANDS FORESTRY.
3100. IMPORTANT FOREST PLANTS.
3101. FIELD FOREST ECOLOGY.
3102. SOUTHERN FOREST RESOURCE TOUR.
3104. FOREST ECOLOGY.
3201. FIELD FOREST MEASUREMENTS.
3225. DIRECTED STUDY EXPERIENCE.
5100. SILVICULTURE.
5101. FIELD SILVICULTURE.
5103. ADVANCED FOREST TREE BIOLOGY.
5106. SENIOR SILVICULTURE SEMINAR.
5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS.
5114. FOREST HYDROLOGY.
5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS.
5121. TREE PHYSIOLOGY LABORATORY.
5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
5140. APPLICATION OF SILVICULTURE IN NORTH AMERICAN FOREST TYPES.
5152. FOREST GENETICS.
5153. ADVANCED FOREST HYDROLOGY.
5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
5212. NATURAL RESOURCES INVENTORY.
5215. FOREST FIRE MANAGEMENT.
5216. SPECIAL TOPICS IN FOREST FIRE MANAGEMENT.
5217. FIELD TECHNIQUES FOR PRESCRIBED BURNING.
5218. FIELD TECHNIQUES FOR FOREST FIRE CONTROL.
5220. REMOTE SENSING, FOREST RESOURCES INVENTORY.
5226. FOREST ECONOMICS AND PLANNING.
5231. RANGE MANAGEMENT.
5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
5248. HARVESTING AND ENGINEERING.
5253. FOREST BIOMETRY.
5255. FOREST RESOURCES SURVEY DESIGN.
5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT.
5401. SENIOR TOPICS.
5408. FORESTRY IN THE URBAN ENVIRONMENT.

5500. URBAN FOREST MANAGEMENT.
5700. COLLOQUIUM IN FOREST BIOLOGY.
8100. RESEARCH PROBLEMS: SILVICULTURE.
8101. RESEARCH PROBLEMS: FOREST-TREE PHYSIOLOGY.
8102. RESEARCH PROBLEM: FOREST-TREE GENETICS.
8103. RESEARCH PROBLEMS: FOREST HYDROLOGY.
8105. ADVANCED FIELD SILVICULTURE.
8106. TOPICS IN SILVICULTURE—FOREST SOILS.
8200. RESEARCH PROBLEMS: FOREST MANAGEMENT.
8201. RESEARCH PROBLEMS: FOREST ECONOMICS.
8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS.
8203. RESEARCH PROBLEMS: FOREST RECREATION.
8204. RESEARCH PROBLEMS: FOREST POLICY.
8205. RESEARCH PROBLEMS: REMOTE SENSING.
8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS.
8210. RESEARCH METHODS IN FORESTRY.
8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.
8213. TOPICS IN WILDLAND HYDROLOGY.

Plant Pathology (PlPa)

5050. FOREST PATHOLOGY.

LAKES AND WETLANDS

Botany (Bot)

5231. INTRODUCTION TO THE ALGAE.

Civil Engineering (CE)

8430. LAKE AND RESERVOIR HYDRODYNAMICS.

Ecology and Behavioral Biology (EBB)

5601. LIMNOLOGY.
5607. ECOLOGY OF ANIMAL PLANKTON.
5611. LIMNOLOGY LABORATORY.

Geology and Geophysics (Geo)

5601. LIMNOLOGY.
8602. ADVANCED LIMNOLOGY.

LAND USE

Agricultural and Applied Economics (AgEc)

5600. LAND ECONOMICS.
8360. LAND ECONOMICS AND POLICY.

Geography (Geog)

3343. LAND USE AND STATE GOVERNMENT.
3344. LAND USE AND THE FEDERAL GOVERNMENT.
8340. SEMINAR: LAND USE PLANNING.
8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.
8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.

Landscape Architecture (LA)

1031. INTRODUCTION TO LANDSCAPE ARCHITECTURE.
5107. REGIONAL LANDSCAPE DESIGN.
5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS.
8390. DESIGNING THE LONG-TERM LANDSCAPE.

Law (Law)

5201. LAND USE PLANNING.

Public Affairs (PA)

5601. LAND USE.
5622. DEVELOPMENT MANAGEMENT SYSTEMS.
8600. SEMINAR: LAND USE PLANNING.
8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS.

LIFE SCIENCES

Biology (Biol)

1008. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH.
1008H. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH.
1009. GENERAL BIOLOGY.
1009H. GENERAL BIOLOGY.
1101. HEREDITY AND HUMAN SOCIETY.
1103. GENERAL BOTANY.
1106. GENERAL ZOOLOGY.
1951, 1952, 1953. BIOLOGY COLLOQUIUM.
3011. ANIMAL BIOLOGY.
3012. PLANT BIOLOGY.
3042. FIELD PROBLEMS IN ECOLOGY.
3112. BIOLOGICAL RHYTHMS.
5041. ECOLOGY.

Ecology and Behavioral Biology (EBB)

3001. INTRODUCTION TO ECOLOGY.
3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS.
5051. ANALYSIS OF POPULATIONS.
5052. THEORETICAL POPULATION ECOLOGY.
5114. VERTEBRATE BIOLOGY.
5608. ECOSYSTEMS: FORM AND FUNCTION.

Entomology (Ent)

5040. INSECT ECOLOGY.
5320. ECOLOGY OF AGRICULTURE.

Fisheries and Wildlife (FW)

5129. MAMMALOGY.

Genetics and Cell Biology (GCB)

3002. HUMAN GENETICS, SOCIAL AFFAIRS.

Microbiology (MicB)

3103. GENERAL MICROBIOLOGY.
5352. APPLIED MICROBIOLOGY.

METEOROLOGY AND CLIMATOLOGY

Forest Resources (FR)

3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.

Geography (Geog)

1425. INTRODUCTION TO METEOROLOGY.
3421. CLIMATOLOGY.
5423. ADVANCED CLIMATOLOGY.
5424. APPLIED CLIMATOLOGY.
8420. SEMINAR: CLIMATOLOGY.

Geology and Geophysics (Geo)

8262. QUARTERNARY PALEOECOLOGY AND CLIMATE.

Physics (Phys)

1071. INTRODUCTORY METEOROLOGY.
1075. INTRODUCTORY METEOROLOGY LABORATORY.
5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE.

Soil Science (Soil)

1262. INTRODUCTION TO METEOROLOGY.
5240. MICROCLIMATOLOGY (SOILS).
5424. APPLIED CLIMATOLOGY.

NATURALIST STUDIES

Botany (Bot)

1009. MINNESOTA PLANT LIFE.
1012. PLANTS USEFUL TO HUMANS.
3201. INTRODUCTORY TAXONOMY.
5103. ALGAE, FUNGI, AND BRYOPHYTES.
5801. PLAINS AND BOREAL FLORA.

Ecology and Behavioral Biology (EBB)

5008. QUATERNARY ECOLOGY.
5014. ECOLOGY OF PLANT COMMUNITIES.
5016. ECOLOGICAL PLANT GEOGRAPHY.
5122. PLANT/ANIMAL INTERACTIONS.
5129. MAMMALOGY.
5132. HERPETOLOGY.
5134. INTRODUCTION TO ORNITHOLOGY.
5814. COMMUNITY STRUCTURE AND FUNCTION.

Entomology (Ent)

3005. INTRODUCTORY ENTOMOLOGY.
5600. FIELD ENTOMOLOGY.

Forest Resources (FR)

3100. IMPORTANT FOREST PLANTS.
5103. ADVANCED FOREST TREE BIOLOGY.
5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE PLANNING.
5152. FOREST GENETICS.
5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
5700. COLLOQUIUM IN FOREST BIOLOGY.

Geography (Geog)

3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY.

OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

Aerospace Engineering and Mechanics (AEM)

5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE.

Communication Disorders (CDis)

5704. NOISE AND MAN.

Environmental Health (PubH)

5211. INDUSTRIAL HYGIENE ENGINEERING.
5213. ERGONOMICS IN OCCUPATIONAL HEALTH.
5215. APPLIED OCCUPATIONAL TOXICOLOGY.
5233. BIOHAZARD CONTROL IN BIOMEDICAL LABORATORIES.
5271. OCCUPATIONAL EPIDEMIOLOGY.

Mechanical Engineering (ME)

5603. THERMAL ENVIRONMENTAL ENGINEERING.
5607. INDUSTRIAL VENTILATION AND CONTAMINANT CONTROL.

RECREATION AND OUTDOOR EDUCATION

Elementary Education (Elem)

5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION.

Forest Resources (FR)

3232. MANAGEMENT OF RECREATIONAL LANDS.
5233. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING.
5236. FOREST RECREATION PLANNING.
5257. RECREATION LAND POLICY.
5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR.
5406. FORESTRY WORKSHOP FOR TEACHERS.
8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS.

Landscape Architecture (LA)

5010. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING.
5105. RECREATIONAL PLANNING AND DESIGN.

Recreation, Park, and Leisure Studies (Rec)

5160. CONSERVATION OF PARK RESOURCES.
5250. FINANCING LEISURE SERVICES.
5300. FOUNDATIONS OF OUTDOOR EDUCATION.
5310. PROGRAMMING IN OUTDOOR EDUCATION.
5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING.

RESOURCE MANAGEMENT

Agricultural and Applied Economics (AgEc)

3610. COMMUNITY RESOURCE DEVELOPMENT.
5650. ECONOMICS OF NATURAL RESOURCE POLICY.
8264. RESOURCE ECONOMICS.
8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS.

Economics (Econ)

5611. RESOURCE AND ENVIRONMENTAL ECONOMICS.

Fisheries and Wildlife (FW)

1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
5455. AQUACULTURE.

Forest Resources (FR)

1201. CONSERVATION OF NATURAL RESOURCES.
1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES.
3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
3300. ELEMENTS OF SURVEYING.
5200. AERIAL PHOTO INTERPRETATION.
5212. NATURAL RESOURCES INVENTORY.
5220. REMOTE SENSING, FOREST RESOURCES INVENTORY.
5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
5269. INTERDISCIPLINARY SEMINAR I.
5270. INTERDISCIPLINARY SEMINAR II.
5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
5412. ADVANCED REMOTE SENSING.
8205. RESEARCH PROBLEMS: REMOTE SENSING.

Geography (Geog)

3345. ENERGY AND MINERALS.
3351. FOOD PRODUCTION AND DISTRIBUTION.
5344. HISTORICAL GEOGRAPHY OF RESOURCE USE IN THE UNITED STATES.

Landscape Architecture (LA)

5099. RCD INTERDISCIPLINARY SEMINAR I.
5100. RCD INTERDISCIPLINARY SEMINAR II.
8390. DESIGNING THE LONG-TERM LANDSCAPE.

Management (Mgmt)

8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES.

Resource and Community Development (RCD)

5099. RCD INTERDISCIPLINARY SEMINAR I.
5100. RCD INTERDISCIPLINARY SEMINAR II.

Soil Science (Soil)

5104. AGRICULTURAL SYSTEMS ANALYSIS AND MODELING.

SOIL RESOURCES

Agricultural Engineering (AgEn)

5540. EROSION CONTROL, WATERSHED ENGINEERING.
5550. DRAINAGE AND IRRIGATION ENGINEERING.

Agricultural Engineering Technology (AgEt)

5400. DRAINAGE AND IRRIGATION.

Forest Resources (FR)

1122. INTRODUCTORY SOIL SCIENCE.

Geography (Geog)

3451. GEOGRAPHY OF SOILS.

Soil Science (Soil)

1020. THE SOIL RESOURCE.

1122. INTRODUCTORY SOIL SCIENCE.
3118. SEMINAR: SOIL POLLUTION AND PUBLIC POLICY.
3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
5340. ORGANIC AND PESTICIDAL RESIDUES.
5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.
5560. USES AND INTERPRETATION OF SOIL SURVEY INFORMATION.
5610. SOIL BIOLOGY.

WATER RESOURCES

Agricultural Engineering (AgEn)

8500. HYDROLOGIC MODELING – SMALL WATERSHEDS.

Civil Engineering (CE)

5401. WATER RESOURCES ENGINEERING.
5405. HYDROLOGY AND HYDROLOGIC DESIGN.
5425. GROUNDWATER MECHANICS.
5426. COMPUTER MODELING OF GROUNDWATER FLOW.
8406. SEMINAR: ADVANCED HYDROLOGY.
8419. WATER RESOURCES SYSTEMS SIMULATION.
8425. ADVANCED GROUNDWATER MECHANICS.
8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.
8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.

Geology (Geo)

5611. GROUNDWATER GEOLOGY.
8612. ANALYTICAL GEOHYDROLOGY.

Geography (Geog)

5444. GEOGRAPHY OF WATER RESOURCES.

WATER SUPPLY AND WATER QUALITY

Agricultural Engineering (AgEn)

5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING.

Agricultural Engineering Technology (AgEt)

5410. HYDROLOGY AND WATER QUALITY.

Civil Engineering (CE)

5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS.
5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
5505. WATER QUALITY ENGINEERING.
5506. ENVIRONMENTAL WATER CHEMISTRY.
5507. TECHNIQUES OF WATER AND WASTEWATER ANALYSIS.
5530. MODELING AND PROCESS CONTROL OF WATER AND WASTEWATER TREATMENT.
5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT – PART II.
8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.
8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS.
8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Environmental Health (PubH)

5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS.
5243. WATER AND HEALTH.

Forest Resources (FR)

5458. WATER QUALITY MANAGEMENT: ECOSYSTEM APPROACHES.

PART II. FULL COURSE DESCRIPTIONS LISTED BY FIELD OF INSTRUCTION

AEROSPACE ENGINEERING AND MECHANICS (AEM)

Institute of Technology

107 Akerman, 625-8000

5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE. (4 cr; prereq Phys 1291, Math 3221 or equiv; 3 lect and 1 lab hrs per wk)

Derivation of the wave equation, plane wave solution, transmission and reflection at boundaries, resonators and mufflers, three-dimensional wave propogation, properties of environmental noise sources, hearing and perception of sound, acoustical properties of rooms, laboratory experience in sound and noise measurements and noise control techniques.

AGRICULTURAL AND APPLIED ECONOMICS (AgEc)

College of Agriculture

231 Classroom Office Building, 625-1222
K. William Easter, 317G Classroom Office Building, 625-7728

3610. COMMUNITY RESOURCE DEVELOPMENT. (4 cr; prereq 1020-1030 or Econ 1001-1002 or #)

Basic concepts of resource use including physical and economic classifications; physical and economic feasibility; benefits and costs; external effects; cost sharing; selected resource use problems. Economic areas and units for planning and development; generation of alternative program elements and development of consequences; problems in choosing elements for an optimum resource development program.

5600. LAND ECONOMICS. (4 cr for undergrad, 3 cr for grad; prereq 3101, 3102, or Econ 3101, 3102 or #)

Land as a factor of production; land use, classification, and value; sales and rental markets for land; domestic and foreign land policies.

5650. ECONOMICS OF NATURAL RESOURCE POLICY. (4 cr for undergrad, 3 cr for grad; prereq 3101 or Econ 3101 or Econ 5151 or #)

Application of economic analysis, including project evaluation, to current natural resource issues. Emphasis on conservation and resource scarcity, environmental quality, population growth, and resource use issues and their implications for public policy.

8264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5162 or ¶Econ 5162 or #)

Economic analysis relevant to resource use and management; concepts of joint production and joint costs; external effects of resource decisions; applications of public finance, welfare economics, capital theory, and discount rates; cost-benefit analysis and other decision-making approaches; investment and management problems related to water resources, outdoor recreation, forestry, and fisheries; economic problems of air pollution and environmental quality.

8360. LAND ECONOMICS AND POLICY. (3 cr; offered when demand warrants)

8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS. (3 cr; offered when demand warrants)

AGRICULTURAL ENGINEERING (AgEn)

Institute of Technology

213 Agricultural Engineering, 625-7733
J.L. Nieber, 203 Agricultural Engineering, 625-6724
C.J. Clanton, 230 Agricultural Engineering, 625-9218
I. D. Moore, 205 Agricultural Engineering, 625-6770

5540f. EROSION CONTROL, WATERSHED ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 5401 or #; 3 lect and 3 lab hrs per wk)

Measurement and mechanics of watershed runoff and soil erosion. Estimating peak runoff, soil losses, and sediment yields. Environmental effects. Principles of small watershed planning for flood control, water storage, and sediment control. Hydraulic design of graded and storage-type terraces, grass waterways, diversions, and erosion control structures.

5550w. DRAINAGE AND IRRIGATION ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 5401 or #; 3 lect and 3 lab hrs per wk)

Flow of water through agricultural soils. Irrigation and drainage requirements, salinity control, evapotranspiration, water supply development, and control. Conveyance of drainage and irrigation waters. Considerations for design, layout, and construction of irrigation and drainage systems. Institutional, environmental, and economic aspects of soil moisture control.

5910w. AGRICULTURAL WASTE MANAGEMENT ENGINEERING I. (4 cr; prereq IT upper division or grad IT major, 3052, Chem 1005; 3 lect and 3 lab hrs per wk)

Sources and characteristics of agricultural wastes including animal manures, crop residues, sediments, processing wastes, and domestic wastes. Effects on environment. Sanitary collection, storage, treatment, and disposal. Utilization of liquid and solid wastes. Nonurban water supply and quality.

8500s. HYDROLOGIC MODELING—SMALL WATERSHEDS. (4 cr; prereq CE 5405, grad IT major; 3 lect and 1 rec hrs per wk; offered 1988-89 and alt yrs)

Study and representation of hydrologic processes by mathematical models; infiltration, overland flow, return flow, evapotranspiration, channel flow, and storage. Time-flow relationships. Linear and nonlinear methods. Frequency relationships. Emphasis on parametric methods.

AGRICULTURAL ENGINEERING TECHNOLOGY (AgEt)

College of Agriculture

213 Agricultural Engineering, 625-7733
J.L. Nieber, 203 Agricultural Engineering, 625-6724
C.J. Clanton, 230 Agricultural Engineering, 625-9218
I. D. Moore, 205 Agricultural Engineering, 625-6770

5400s. DRAINAGE AND IRRIGATION. (4 cr; prereq Soil 3210; 3 lect and 2 lab hrs per wk)

Soil moisture excesses and deficiencies. Theory and design of tile drainage, surface drainage, and sprinkler irrigation systems. Development of irrigation water supplies. Selection of pumps and power units for drainage and irrigation. Economic feasibility. Legal problems and procedures.

5410w. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phys 1041, Chem 1004, 1005; 3 lect, 3 lab, and 1 rec hrs per wk)

The hydrologic cycle—precipitation, infiltration, evaporation, surface and subsurface runoff, and groundwater recharge. Flow in streams, flow in aquifers, and flow measurement. Soil erosion, sediment transport, and deposition. Chemical pollution of surface water and groundwater.

ANTHROPOLOGY (Anth)

College of Liberal Arts

215 Ford Hall, 625-3400
Timothy Dunnigan, 214 Ford Hall, 625-0879

5116w. CULTURAL ECOLOGY. (4 cr; prereq 1101, 1102 or 5102, one ethnographic area course or #)

The literature of cultural ecology, biological approach to ecosystems and population studies.

5117w. ENERGY, RESOURCE USE, AND SYSTEM CHANGE. (4 cr)
Social-cultural system factors in the development, production, control, distribution and use of energy, water and other key natural resources in the United States and other societies. Social-cultural evolution. Interaction among different societies, growth and no-growth issues, climate warming, emerging global interdependence.

ARCHITECTURE (Arch)

Institute of Technology

110 Architecture, 624-7866
Julia Robinson, 110 Architecture, 624-7866

3001. ENVIRONMENTAL DESIGN: THEORY AND PROCESS. (4 cr; §LA 3001; soph standing)
Design process and theory making and interpreting environments. Effects of means on environmental outcomes: rooms, buildings, landscapes, cities. Issues of arts, natural and social sciences explored in readings, lectures, discussions, projects.

3002. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT (4 cr; §LA 3002; prereq Arch 3001; soph standing)
Interaction of people with the environment. Relations between individuals, groups, culture and environment. Concepts such as: home, place, comfort, public and private, presented as biologically, socially and culturally based. Focus on range of scales: rooms, buildings, cities and landscapes. Lectures, readings, discussions, and projects.

3060. TECHNOS: FORCE, FORM AND ARCHITECTURE. (4 cr; prereq Arch 1021, Arch major, and ¶Arch 3081)
Introduction to fundamental conceptual frameworks that relate science, technology, and building expression to architectural form. Present day to ancient periods. Climate, force, materials and structures case studies.

3064-3065f,w. ENVIRONMENTAL MANAGEMENT AND CONTROL. (4 cr per qtr; prereq Arch major or adult special, 3062, 3083 or #; 4 lect hrs per wk)
Environmental-mechanical considerations including comfort technology, space habitability, climate, psychometrics, control and management systems; waste management including plumbing systems and waste disposal techniques. Electrical systems, energy, power distribution and machinery; lighting systems, physiology of seeing, light sources and control; spatial acoustics, noise barriers, absorption.

BIOLOGY (Biol)

College of Biological Sciences

123 Snyder Hall, 624-2244
Kathleen Peterson, 223 Snyder Hall, 624-9717

1008. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH. (4 cr)
Description of evolution as the unifying principle in biology; organization and change in the biological world and the origin of humans.

1008H. INTRODUCTORY BIOLOGY: AN EVOLUTIONARY APPROACH. (4 cr)
For description, see 1008. Intended especially for honors students or their equivalent who plan to major in a life science discipline.

1009. GENERAL BIOLOGY. (5 cr)
Introduction to the principles of biology. The cell, metabolism, heredity, reproduction, ecology, and evolution. Includes laboratory.

1009H. GENERAL BIOLOGY. (5cr; prereq honors division or 3-4 years high school math, high school chem or Δ)
Intended especially for honors students or their equivalent who plan to major in a life science discipline.

1101f,w,s. HEREDITY AND HUMAN SOCIETY. (4 cr; §GCB 3002; no cr if taken after 5003 or GCB 3022; for students in programs not directly related to biological sciences)
Principles of heredity and their social and cultural implications.

1103f,w,s,su. GENERAL BOTANY. (5 cr; §3012; prereq 1009; students who plan to major in biology in CLA or in any bioscience major in CBS should take 3012)
Levels of organization of plants, plant function, plant growth and development, plant reproduction.

1106f,w,s,su. GENERAL ZOOLOGY. (5 cr; prereq 1009)
Survey of animal phyla; structure, function behavior, adaptation, and evolutionary relationships.

1951f,1952w,1953s. BIOLOGY COLLOQUIUM. (S-N only)
An introduction to the diversity of biology through seminars, lab tours, undergrad research, trips to Itasca Biological Station, and interaction with other biology students and faculty.

3011f,w,s,su. ANIMAL BIOLOGY. (5 cr; §1106; prereq 1009, Chem 1005)
Comparison of ways different phyla have solved similar physiological problems. Laboratory includes survey of major animal groups and physiological experiments.

3012f,w,s. PLANT BIOLOGY. (5 cr; §1103; prereq 1009, Chem 1005)
Plant diversity and evolution; structure and function of the plant cell and of the whole organism; growth and development of plants.

3042f,w,s. FIELD PROBLEMS IN ECOLOGY. (2 cr; prereq 5041 or #)
Student research projects on selected ecological problems.

3051. BIOLOGY AND THE FUTURE OF THE EARTH. (4 cr; A-F or S-N; designed primarily for non-majors)
Nontechnical discussion of biological principles in environmental and social systems, e.g. air and water pollution, energy policy, population growth, resource management, food supplies, wilderness values, waste disposal, environmental health, toxicology, biodiversity, war, bioethics and ecophilosophy.

3052s. ENVIRONMENTAL HEALTH AND TOXICOLOGY. (4 cr)
This course is part of a Five-College Cooperative Curricular Project on "Garbage, Government, and the Globe". Students are encouraged to register for more than one course to broaden their perspectives on the topic. For the other four courses, see: BGS 3019, IT 3101, Pol 3970, and Soil 1020. During spring quarter, students registered for these courses will also participate in a joint seminar. Why are toxic materials dangerous? What do they do to us and to our environment? This course will look at how chemical substances move through the environment, as well as what happens when we eat, drink, or breathe them. We will also study ways of reducing our exposure to toxins, along with repair mechanisms and protective factors that mitigate their effects. Finally, we will consider risk analysis systems to understand the comparative dangers of various types of environmental hazards.

3112w. BIOLOGICAL RHYTHMS. (4 cr; §5112; prereq 1009 or #)
Timing mechanisms and rhythms of organisms in physiological processes, ecological adaptation, and health; current hypotheses concerning their cellular nature.

5041. ECOLOGY. (4 cr; prereq Math 1142 or 1211, Biol 1103 or 1106 or 3011 or 3012)
Growth, structure, and evolution of populations. Pairwise biotic interactions between species, effect on diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems.

5951. SOCIAL USES OF BIOLOGY. (4 cr; S-N only; prereq 10 cr sciences)
Influence of biological science on the quality of human life: agriculture, medicine, occupational health, environmental science, and theories of human nature. Responsibilities and roles of biologists in policy formulation in the scientific and political world.

BUSINESS, GOVERNMENT, AND SOCIETY (BGS)

School of Management

30 Management and Economics, 625-0027
A. Marcus, 830 Management and Economics, 624-2812

3002. BUSINESS AND SOCIETY. (4 cr; prereq at least 90 cr completed or in progress; may not be taken S-N)

Examines the strategic and dynamic relations of business and society in a goal-oriented and problem-solving context. Focuses on the interfaces of business institutions with the physical environment, the social milieu, the political process and economic activity. Gives specific attention to the ongoing debate regarding national priorities and the respective roles of the private and public sectors concerning the challenges confronting U.S. society. Includes assessment of the concept, determinants, and indicators of the "quality of life" and the social responsibilities of business.

3003. BUSINESS AND THE NATURAL ENVIRONMENT. (4 cr; prereq jr or sr and at least 90 credits completed or in progress; may not be taken S-N)

Business and its relationship to the natural environment. The use by industry of renewable and nonrenewable resources. Environmental deterioration caused by businesses to air, land, and water. Business solutions to environmental problems. May emphasize energy in some quarters.

3019s. MANAGEMENT AND THE NATIONAL ENVIRONMENT: ISSUES FOR INTERNATIONAL BUSINESS. (4 cr)

This course is part of a Five-College Cooperative Curricular Project on "Garbage, Government, and the Globe". Students are encouraged to register for more than one course to broaden their perspectives on the topic. For the other four courses, see: Biol 3052, IT 3103, Pol 3970, and Soil 1020. During spring quarter, students registered for these courses will also participate in a joint seminar. Environmental and natural resource problems have the capacity to profoundly affect a company's operations, profitability, and even survival. How will efforts to address problems such as atmospheric and climatic change, marine pollution, energy availability and hazardous waste management affect economic competitiveness and the domestic and international operations of corporations? How do and can companies cope with these issues? What is the role of business in addressing environmental problems? What are the implications of such issues for general managers and functional specialists? Cases such as Union Carbide and Bhopal will be among the methods used to explore these and related questions.

8055. BUSINESS, GOVERNMENT, AND MACROECONOMICS. (4 cr)

Roles of government and business in society; alternative systems of economic and political values; social, political, economic, and cultural conflicts affecting the business sector.

8202. EXTERNAL AFFAIRS MANAGEMENT. (4 cr; prereq MBA 8055, grad mgmt/IR student or # and grad school mgmt approval)

Managing key aspects and issues that face business managers including environmental protection and natural resource issues. Discussion of development of legal framework for environmental control.

CIVIL ENGINEERING (CE)

Institute of Technology

122 Civil and Mineral Engineering, 625-5522
M. Semmens, 150 Civil and Mineral Engineering, 625-9857

5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION. (4 cr; prereq #)

Measuring transportation productivity and energy consumption; application of control theory for improving transportation productivity; simulation of energy-conservation policies and effect of such policies on transportation ridership and economics through time; transportation use and energy consumption in relation to urban and rural structures; case studies.

5401. WATER RESOURCES ENGINEERING. (4 cr; prereq IT or grad student, 3400 or #; 3 lect and 3 lab hrs per wk)

Introduction to water resources engineering including flow in conduits, pumps, open channels and culverts; introduction to flow measurements, hydraulic structures and systems approach to water resources engineering.

5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq IT or grad student, 5401 or #; 3 lect and 3 lab hrs per wk)

Hydrologic cycle, precipitation, evaporation, infiltration, runoff analysis, flood routing, statistical procedures in hydrology, urban hydrology, introduction to mathematical models of medium and large watersheds, application of hydrology to design of outlet works and flow control structures.

5425. GROUNDWATER MECHANICS. (4 cr; prereq IT or grad student, 3400 or #)

Basic equations. Shallow confined and unconfined flows, two-dimensional flow in the vertical plane, and transient flow. Flow from rivers and lakes toward wells. Determination of streamlines and pathlines in two and three dimensions. Introduction to containment transport. Elementary computer modeling.

5426. COMPUTER MODELING OF GROUNDWATER FLOW. (4 cr; prereq IT or grad student, 3400 or #)

Principles of Analytic Element Method, Boundary Integral Equation Method, Finite Element Method, Finite Difference Method. Applications of these four methods to field problems using existing computer programs. Derivation and interpretation of basic equations for contaminant transport in groundwater. Implementation of transport mechanisms in the various computer models.

5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS. (4 cr; prereq 3400 or #, IT student or grad)

Planning and engineering design considerations in developing water supply systems for urban centers. Supply quality, storage, treatment, distribution, and cost analysis.

5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS. (4 cr; prereq IT or grad student, 3400, 3500 or #)

Planning and engineering design considerations in developing waste disposal systems for urban centers. Volumes and quality of waste streams, treatment and ultimate disposal of domestic and industrial wastewaters, and storm water runoff. Environmental effects, cost, and political aspects of ultimate disposal.

5505. WATER QUALITY ENGINEERING. (4 cr; prereq IT or grad student, 3500 or #)

Chemical and physical properties of natural waters, introduction to aquatic biology, and ecological considerations of element cycling of natural carbon, nitrogen, phosphorus, oxygen, and anthropogenic chemical species (pesticides, PCBs, heavy metals). Physical and chemical processes of water treatment.

5506. ENVIRONMENTAL WATER CHEMISTRY. (4 cr; prereq IT or grad student, Chem 1006 or #; 3 lect and 1 rec hrs per wk)

Composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and water quality parameters in natural waters; methods of evaluation to determine fate of organic pollutants.

5507. TECHNIQUES OF WATER AND WASTEWATER ANALYSIS. (4 cr; prereq 5500, 5501, 5506 or #, IT upper div student or grad)

Methods of sampling and examining natural waters and wastewaters; technique used in analysis of general water quality parameters, nutrients, major and minor ions, and natural and synthetic organic matter, with emphasis on modern analytical procedures. Composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and waters; methods of evaluation to determine fate of organic pollutants.

5510. SOLID AND HAZARDOUS WASTE MANAGEMENT. (4 cr)

Analysis and design of engineered systems for collection, transportation, processing, and disposal of solid and hazardous waste materials. Waste characteristics affecting management options, discussion of relevant regulatory legislation.

5515. WATER AND WASTEWATER MICROBIOLOGY. (4 cr; prereq Chem 1005, Math 1231)

Analysis of role of microbes in environmental degradation and pollution control. Organism growth and selection in wastewater treatment systems. Pathogenic organisms in water supply. System control using microbial based indicators.

5530. MODELING AND PROCESS CONTROL OF WATER AND WASTEWATER TREATMENT. (4 cr; prereq 5500, 5501 or #)
Mathematical modeling and simulation of water and wastewater treatment processes; introduction to control theory, design of control systems and their application to computer-aided process control.

5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY. (4 cr; prereq 5501, 5401 or #)
Fate of chemicals in groundwater and soils will be analyzed and modeled. Transport, dispersion, chemical-biological transformations and accumulation will be considered. Models will be used to study in situ clean-up of groundwater and aquifers and simulate time dependent changes in pollutant concentration.

5580. INTRODUCTION TO ENVIRONMENTAL LAW FOR ENGINEERS. (3 cr; 3 lect hrs per wk)
Common statutory and regulatory law relevant to the work of civil and environmental engineers; history and development of environmental control with emphasis on public policies behind decision making in courts, legislatures, and administrative agencies and tribunals.

5581. ENVIRONMENTAL LAW. (4 cr; prereq 5580)
Specific provisions of federal and Minnesota statutory and regulatory law such as NEPA, TOSCA, RCRA, the Clean Air Act, and the Minnesota Environmental Rights Act; history of these acts in courts.

8406. SEMINAR: ADVANCED HYDROLOGY. (1 cr)
Weekly seminar by staff, students, and guest speakers.

8419. WATER RESOURCES SYSTEMS SIMULATION. (4 cr prereq 5401 or #)
Computer simulation of water resource systems, including hydrology systems stream flow and quality systems, economic systems and sociopolitical systems using deterministic and stochastic approaches.

8425. ADVANCED GROUNDWATER MECHANICS. (4 cr; prereq 5425 or #)
Conforma mapping techniques for two-dimensional steady groundwater flow. The hodograph method. Problems involving a free boundary and horizontal drains. Boundary value problems. Application of boundary integral equation techniques.

8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #)
Overview of hydrodynamic phenomena, analysis of density stratification, energy and momentum transfer through a water surface, wind effects of stratification and circulation, standing of progressive waves, stratified flow, density currents, selective withdrawal, mixing.

8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT. (3 cr; prereq 5500, 5501, or #)
Theoretical principles underlying physical and chemical processes for water and wastewater treatment including sedimentation, flotation, adsorption, precipitation, and disinfection.

8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT – PART II. (3 cr; prereq 5500, 5501, 5506 or #)
Theoretical principles, design considerations, and performance of processes not covered in CE 8500. Coagulation flocculation, filtration, membrane processes, gas transfer, sludge dewatering, mixing, and other processes commonly used in water pollution control.

8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT. (3 cr; prereq 5501 or #)
Theoretical principles underlying chemical and biological wastewater treatment processes including aerobic and anaerobic biological processes for carbon and nitrogen removal, aeration, and chemical processes for phosphorus and nitrogen removal.

8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq Chem 5506 or #)

Application of principles of physical chemistry to quantification of chemical processes in aquatic systems. Natural waters as equilibrium and dynamic systems. Ionic equilibria; protolysis, complexation, solubility, and redox equilibria. Precipitation and mineral dissolution kinetics. Aqueous metal species in electrolyte solutions.

8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq 8505 or #)

Natural interactions with rock and soil, precipitation and atmospheric fallout; industrial and domestic sources. Nature of aqueous metals in term of electrolyte solutions, hydrolysis reactions, complexation, chelation, redox, solubility, and precipitation. Interactions at solid-solution interfaces in terms of phenomenological and general models for adsorption. Hydrodynamic, biological, and chemical factors affecting distribution, transport and removal from aqueous phase. Computer techniques emphasized.

8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS. (4 cr; prereq #)

Introduction to hydrologic transport and water quality simulation in natural water systems. Mixed cell models, advection, turbulent diffusion and dispersion in one- and two-dimensional systems. Chemical and biological kinetics in water quality models. Applications to temperature, dissolved oxygen, primary productivity, and other water quality management problems in rivers, lakes, and reservoirs. Deterministic versus stochastic models. Water quality dynamics.

8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS. (1-5 cr; prereq 8550)

Case studies of specific aquatic streams and lake systems.

8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING. (1 cr; prereq #)

Selected environmental engineering topics discussed by students, staff members, and guests.

COMMUNICATION DISORDERS (CDis)

College of Liberal Arts

110 Shevlin Hall, 624-3322
W.D. Ward, 2630 University Ave. S.E., 627-4694

5704. NOISE AND MAN. (4 cr; prereq 5301 or #)

Temporary and permanent effects of steady, intermittent, and impulse noise on hearing and health. Annoyance and community noise. Noise measurement, reduction, and control; ear defenders and their limitations. Hearing conservation programs; preemployment testing and monitoring audiometry.

ECOLOGY AND BEHAVIORAL BIOLOGY (EBB)

College of Biological Sciences

109 Zoology, 625-4466
Franklin H. Barnwell, 109 Zoology, 625-4466

3001. INTRODUCTION TO ECOLOGY. (4 cr; open to jrs and above but not to biology majors)

Basic concepts in ecology; the organization, development, and functioning of ecosystems; population growth and regulation. Human impact on ecosystems.

3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS. (4 cr; §3001; not open to biology majors; prereq Math 1231)

Description and analysis of the spatial and temporal interactions between populations in ecosystems; processes affecting populations; transformations of energy and materials in the biosphere. Lectures and recitations.

5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or #)

Impact of changes in the physical and biological environment during the Quaternary period on plants and animals. Changes in evolutionary rates, geographical distributions, community composition and fluctuations in population sizes. Impact of prehistoric human culture on the environment, including ecosystem-level changes recorded in sedimentary sequences. Recent climatic changes. General principles of analysis and methods of investigation and interpretation.

5014. ECOLOGY OF PLANT COMMUNITIES. (5 cr; prereq 3004 or Biol 5041, 1 qtr statistics or #)

Methods of describing, sampling, and classifying plant communities; theory of their structure and development, and of the stability of the interactions among their constituent populations. Field trips to examine local vegetation types; analysis of quantitative data.

5016. ECOLOGICAL PLANT GEOGRAPHY. (5 cr; prereq 3004 or Biol 5041, Bot 3201; offered when feasible)

Vegetation regions of the world and North America in detail; ecological principles of plant distribution; interpretation of regional and temporal patterns in distribution of vegetation and taxonomic groups. Field trips to floristic regions of Minnesota.

5051. ANALYSIS OF POPULATIONS. (4 cr; §8001; prereq 3004 or Biol 5041 or #)

Factors involved in the regulation, growth, and general dynamics of populations. Data needed to describe populations, population growth, population models, and regulatory mechanisms.

5052. THEORETICAL POPULATION ECOLOGY. (4 cr; prereq Biol 5041 or #)

Theories of population ecology, including models of growth and regulation of single populations, and of interactions between populations, including competition, predation, mutualism; emphasizes assumptions and rationales of models and their predictions for dynamics, stability, diversity of communities.

5114w. VERTEBRATE BIOLOGY. (4 cr; prereq Biol 1106 or 3011)

Vertebrates; their biology, taxonomy, and distribution.

5116. INTRODUCTION TO ANIMAL PARASITOLOGY. (5 cr; prereq Biol 1106 or 3011)

Parasitic protozoa, worms, and arthropods and their relation to diseases of humans and animals.

5122. PLANT/ANIMAL INTERACTIONS. (4 cr; prereq Biol 3011, 3012 or #)

Herbivority, pollination, seed dispersal. Implications of interaction for plants and animals at organismal, population, and community levels. Coevolution.

5129. MAMMALOGY. (5 cr; §FW 5129; prereq Biol 1106 or 3011 or #; offered 1988-89 and alt yrs)

Recent families and orders of mammals of the world and of genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

5132. HERPETOLOGY. (5 cr; prereq Biol 1106 or 3011 or #)

Distribution, classification, and evolution of amphibians and reptiles of the world. Physiological, morphological, and behavioral aspects of adaptive trends. Laboratory and lecture.

5134. INTRODUCTION TO ORNITHOLOGY. (5 cr; prereq Biol 1106 or 3011)

Laboratory and field course in structure, classification, distribution, migration, habits, habitats, and identification of birds. Weekend trips scheduled.

5136. ICHTHYOLOGY. (4 cr; prereq 15 cr incl Biol 1106 or 3011)

Biology of fishes including development, systematics, anatomy, physiology, and ecology.

5601. LIMNOLOGY. (4 cr; §Geo 5601; prereq Chem 1005 or #)

Description and analysis of the events in lakes, reservoirs, and ponds, beginning with their origins and progressing through their physics, chemistry, and biology. Interrelationships of these parameters and effects of civilization on lakes.

5606. ECOLOGY OF FISHES. (3 cr; prereq Biol 1009 or 1106 or equiv plus 10 cr in the biological sciences; offered 1988-89 and alt yrs)

Ecological requirements of fishes with emphasis on nongame species, habitat, food, interactions among species, and behavioral, anatomical, and physiological adaptations. Fishes in the aquatic ecosystem with emphasis on fresh waters.

5607. ECOLOGY OF ANIMAL PLANKTON. (4 cr; prereq Biol 5041, EBB 5601 or #)

Biology of animal plankton, including distribution of zooplankton in lakes, ecosystem functions such as grazing and remineralization, determination of production, physiological responses to contaminated environments, and important aspects of behavior.

5608f. ECOSYSTEMS: FORM AND FUNCTION. (3 cr; prereq 5601 or Biol 5041, Chem 1002 or 1005; offered 1988-89 and alt yrs)

Nature and development of terrestrial wetland and aquatic ecosystems. Analysis of energy flow and element cycling in relation to environmental controls, self-regulation, natural and human disturbances.

5621. LIMNOLOGY LABORATORY. (2 cr; prereq EBB 5601 or Geol 5601 or #)

Principal techniques for obtaining information about environmental conditions in lakes and streams. Procedures for measuring the abundance and population dynamics of aquatic organisms, with special emphasis on plankton, field instruments, sampling devices, chemical analyses, microscopy and analysis of data. One Saturday field trip.

5613. ASSESSING THE ECOLOGICAL EFFECTS OF POLLUTION. (4 cr; prereq Biol 5041 or equiv, Chem 3301, 3302)

Assessment of effects upon species and ecosystems, methodological problems, initial phases of investigating a new pollutant, problems of prediction.

Courses offered at Lake Itasca Forestry and Biological Station.

5814su. COMMUNITY STRUCTURE AND FUNCTION. (5 cr; limited to 20 students; prereq course in ecology, §; offered annually)

Communities represented in Itasca Park and vicinity, with emphasis on vegetation. Patterns of distribution of the communities, their interaction with the environment, and their dynamic relationships. Methods of community description and analysis.

5815su. FIELD ETHOLOGY. (5 cr; limited to 20 students; prereq course in behavior, Δ; course in statistics recommended)

Field course emphasizing the methods of studying behavior of wild animals. Quantitative techniques; sound recordings and sound tape analysis, capturing and marking techniques. An individual research project and term paper on the social behavior of one species is required. Individual projects require considerable outside time.

5817s,su. VERTEBRATE ECOLOGY. (5 cr; prereq course in ecology, #, Δ)

Field studies on populations and their relationships to local environments; habitat analysis and ecological research methods. Designed primarily for students with fisheries and wildlife management interests. (Lab charge required)

5834s,su. FIELD ORNITHOLOGY. (5 cr; prereq Biol 1106, Δ; offered annually)

Emphasis on the breeding season, biology, behavioral ecology of birds in the Itasca region. Field trips taken to a variety of habitats to learn bird identification and observe and practice techniques for conducting field studies. Laboratory sessions investigate family distinctions and species identification. Individual field projects. Designed primarily for students with fisheries and wildlife management interests. (Lab charge required)

ECONOMICS (Econ)

College of Liberal Arts

1035 Management and Economics, 625-6353
Christina Kelton, 1035 Management and Economics, 625-6353

5611w. RESOURCE AND ENVIRONMENTAL ECONOMICS. (4 cr; prereq 3101 or equiv, 1 qtr calculus; not offered 1989-90)

Exhaustible resources and the theory of optimal depletion. Renewable resources and the theory of optimal use. Will resource scarcity limit growth? Natural resources and natural environments. Environmental pollution and economic efficiency.

EDUCATION, ELEMENTARY (Elem)

College of Education

125 Peik Hall, 625-6372
Pat Williamson, 145 Peik Hall, 625-4044

5348w. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; prereq elementary teaching experience, A-F only)
Classroom and fieldwork activities dealing with models, materials, and methods in the outdoor setting; consideration of broad topics such as ecological relationships, cyclic processes, and change as well as more specific topics such as rocks and minerals, plants and animals, and star-gazing.

ENTOMOLOGY (Ent)

College of Agriculture

219 Hodson Hall, 624-3636
David W. Ragsdale, 416 Hodson Hall, 624-3636

1005. ECONOMIC ENTOMOLOGY. (4 cr; prereq Biol 1009 or #)
Brief introduction to structure and classification of insects; management of insect populations; life histories, habits, and recognition of insect pests of livestock, orchards, field crops, vegetables, and ornamentals.

3005. INTRODUCTORY ENTOMOLOGY. (5 cr; prereq Biol 1009 or equiv)
General morphology, life histories, habits, and classification of insects.

5040. INSECT ECOLOGY. (3 cr; prereq Biol 5041 or EBB 5122 or #)
Synthetic analysis of the causes of insect diversity and of fluctuations in insect abundance. Focus on abiotic, biotic and evolutionary mechanisms influencing insect populations and communities.

5210. INTEGRATED PEST MANAGEMENT (5 cr; prereq 1005 or #)
Management of insect, mite, and weed populations through integration of various methods and techniques.

5250. FOREST ENTOMOLOGY. (4 cr; prereq any two courses among the forestry, zoological, botanical, biological and/or agricultural sciences)
Lectures and laboratory concerning ecology and population management of forest insects, with heavy emphasis on tree factors and biological control.

5280. LIVESTOCK ENTOMOLOGY. (3 cr)
Biology and management of arthropods that affect livestock production systems.

5320. ECOLOGY OF AGRICULTURE. (4 cr; prereq two 3000 or above level courses in agronomy, horticulture or animal science, and two 3000 or above level courses in entomology, plant pathology or soil science or #)
Ecological perspective on post-industrial agriculture. Discussions on the origins of agriculture and comparison of the function and ecology of contemporary and extinct agricultural systems.

5600. FIELD ENTOMOLOGY. (5 cr; prereq introductory biology; offered SSI at Itasca)
Insect fauna in various natural habitats of the park and surrounding areas. Includes field trips and collection and identification of insects, as well as studies of general morphology, life histories, and habitats of local species.

5610. AQUATIC ENTOMOLOGY. (5 cr; prereq 3005 or 5600 or equiv or #; offered at Itasca)
Identification and biology of aquatic and littoral insects in all stages.

8240. COLLOQUIUM IN INSECT ECOLOGY. (3 cr; prereq 5040 or #)
Dispersal, distribution, abundance, natural control and related problems.

ENVIRONMENTAL HEALTH (PubH)

School of Public Health

1155 Mayo Memorial Building, 626-0900
R.D. Singer, 1162 Mayo, 626-0900

5151. ENVIRONMENTAL HEALTH. (3 cr; prereq #)
Methods for promoting human health and comfort by controlling environment.

5152. ENVIRONMENTAL HEALTH. (2 cr)
General principles of environmental health relating macro and micro environments and products consumed or used by people.

5158. HEALTH RISK EVALUATION. (2 cr)
General principles of health risk assessment and management; environmental pollutants; public domain and workplace, legislation and regulations.

5171. ENVIRONMENTAL MICROBIOLOGY. (4 cr; prereq MicB 3103 or #)
Survival, dissemination, significance and monitoring of microorganisms in the environment; application of principles to environmental health problems.

5177. PUBLIC HEALTH BIOLOGY. (3 cr; prereq environmental health students or #)
Introduction to plant and animal forms important in environmental health, biological aspects of water supply, waste treatment, stream pollution, and special phenomena related to human disease transmission.

5181. AIR POLLUTION. (3 cr; prereq general chemistry or #)
An overview of current air pollution problems; sources; chemistry of air pollutants and polluted atmospheres; potential human health effects; air pollution control technology; laws regulating air pollution.

5184. AIR ANALYSIS. (3 cr; prereq 5211 and #)
Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses.

5186. ENVIRONMENTAL CHEMISTRY. (3 cr; prereq general chemistry and organic chemistry or #)
Chemical and physical properties of pollutants that determine distribution and persistence; environmental fate testing; trace analysis of pollutants in the environment.

5201. RADIATION PROTECTION AND MEASUREMENT. (2 cr)
Ionizing radiation sources, detection and measurement, protection principles, health implications.

5202. RADIATION PROTECTION AND MEASUREMENT LABORATORY. (1 cr; prereq 5201 or concurrent with 5201)
Laboratory for 5201.

5211. INDUSTRIAL HYGIENE ENGINEERING. (3 cr)
Concepts and techniques used in occupational health; emphasis on evaluation of potential hazards preventive techniques.

5213. ERGONOMICS IN OCCUPATIONAL HEALTH. (2 cr; prereq #)
Provides a basis for understanding the injury risk of lifting, material handling and repetitive motion activity as it occurs in the occupational environment. Topics covered include: biomechanics, strength testing, back and wrist injury and strategies for reducing the risk of injury.

5215. APPLIED OCCUPATIONAL TOXICOLOGY. (3 cr; prereq 5261 or #)
Basic toxicology and physiology with emphasis on environmental contaminants. Inhalation toxicology of the work environment and air pollution.

5233. BIOHAZARD CONTROL IN BIOMEDICAL LABORATORIES. (2 cr; prereq #)
Topics include assessment of risk; primary barriers, laboratory design criteria, safety devices and equipment; personnel practices; sterilization and decontamination; laboratory animals; and shipping and disposal of biohazardous agents.

5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS. (2 cr)
Introduction to groundwater geology, quality, and treatment; well design, contruction and maintenance, special references to public and environmental health problems.

5243. WATER AND HEALTH. (3 cr)
Occurrences, health effects, and treatment of physical, chemical and biological agents in transmission of waterborne diseases.

5253. INTRODUCTION TO HAZARDOUS WASTE MANAGEMENT. (3 cr)
Review of roles of public and private sectors as generators, disposers and regulators of hazardous wastes. Includes definitions, sources, transportation, handling, treatment, recovery, disposal, and public health implications.

5261. GENERAL ENVIRONMENTAL TOXICOLOGY. (3 cr)
Application of basic biochemical, anatomical, and physiological principles to field of environmental toxicology; assessment of potential health hazards and approaches to solution of problems.

5271s. OCCUPATIONAL EPIDEMIOLOGY. (3 cr; prereq basic course in epidemiology and biostatistics)
Course will include basic principles and concepts in the ascertainment of health effects in the workplace; a review and discussion of strategies for identifying excess risk, evaluating strengths and weaknesses of research techniques, assessing bias and confounding.

FISHERIES AND WILDLIFE (FW)

College of Natural Resources

200 Hodson Hall, 624-3600
WILDLIFE: F. Cuthbert, 320 Hodson Hall, 624-1756
FISHERIES: T.E. Waters, 120 Hodson Hall, 624-7430

1001. ORIENTATION IN FISHERIES AND WILDLIFE. (1 cr; S-N only)
Survey of technical requirements and training of fishery and wildlife technicians and scientists; introduction to fields of work, problems and career outlets.

1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT. (3 cr)
Coverage of various aesthetic, economic and ecological values of wildlife and fisheries resources. Short field exercises and class discussions will be directed at understanding the process of resource management and the ethics of such controversies as sport harvest, subsistence harvest, and native peoples harvest rights.

3052. INTRODUCTION TO FISHERIES AND WILDLIFE. (3 cr)
Introduction to general ecological principles applied to management of fish and wildlife populations and their habitats; survey of legislation, agencies and policy affecting vertebrate populations; natural history of important Minnesota game and nongame vertebrates.

3167. TECHNIQUES OF FOREST WILDLIFE MANAGEMENT. (2 cr; offered at Cloquet)
Biology and management of important forest wildlife species; methods of evaluating forest wildlife populations and habitats.

3600. FISHERIES AND WILDLIFE FIELD TECHNIQUES. (5 cr; FW 3052; at Itasca)
An introduction to a variety of field techniques and skills; planning and implementing field projects; data collection and analysis using microcomputers; written reports and a field journal.

5129. MAMMALOGY. (5 cr; §EBB 5129; prereq Biol 1106 or 3001 or #)
Recent families and orders of mammals of the world and genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

5455. AQUACULTURE. (4 cr; prereq Biol 1009, 1103, 1106 or equiv, Chem 1001-2 or 1004-5 or equiv or #; offered alt yrs)
Role of aquaculture in resource management and world food production; institutional and economic considerations; principles of husbandry of aquatic organisms; interactions between fish metabolism and water quality; nutrition and energetics; fish health and genetics.

5459. ENVIRONMENTAL PHYSIOLOGY OF FISHES. (3 cr; prereq Biol 5041 and EBB 5136 or equiv)
Examination of environmental factors such as temperature, oxygen, salinity, toxic substances and food; effects on fish physiology with an emphasis on bioenergetics.

5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq 1101, 3052, and FR 1201)
Conceptual models of populations, description of population characteristics and computer-assisted estimation of population parameters for the purpose of management. Students select either a fisheries or a wildlife laboratory.

5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS. (4 cr; prereq 5601 or #)
Management of habitats for birds and mammals as developed from the environmental interactions and requirements of these animals. Emphasis is on regional settings and practices. Lab will include team projects and demonstrations.

5604. FISHERY AND WILDLIFE MANAGEMENT. (4 cr; prereq FW 5601 or #)
Fundamental concepts and applications of fisheries management; pond and reservoir fisheries; lake and stream investigations; rehabilitation; lake fisheries management; warm-water and trout stream management.

FOREST RESOURCES (FR)

College of Natural Resources

110 Green Hall, 624-3400
Alan Ek, 204 Green Hall, 624-3098

1122. INTRODUCTORY SOIL SCIENCE. (4 cr; prereq Chem 1001 or 1004)
Basic physical, chemical, and microbiological properties of soil. Soil genesis, classification, and principles of soil fertility. Lectures and laboratory.

1200. INTRODUCTION TO FOREST RESOURCES. (3 cr)
Multiple forest resources and their management. History, policy, and current issues in forest resources. Lectures and laboratory.

1201. CONSERVATION OF NATURAL RESOURCES. (3 cr)
Development of thought on natural resource conservation in the United States. Renewable resources and their management problems; resource conservation and environmental management related to basic ecological principles.

1202. FARM AND SMALL WOODLANDS FORESTRY. (3 cr for non-forestry majors, 2 cr for majors [3 cr with paper]; prereq for majors 1100 or ¶1100)
Status and problems of the small woodland owner. Factors influencing tree growth. Cutting practices for and marketing products of small woodlands. Establishment and care of plantations, shelterbelts, and windbreaks. Field trips.

1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES. (3 cr; §1201; for non-forestry students)
Ecological, social, and economic implications of Minnesota's soil, water, forest, wildlife, and other resources are studied in field exercise and group discussions at nature centers and natural areas. Environmental teaching techniques for the elementary indoor classroom.

3100. IMPORTANT FOREST PLANTS. (1 or 2 cr; prereq Biol 1103; given at Itasca)
Identification of forest plants as related to forest types.

3101. FIELD FOREST ECOLOGY. (3 cr; prereq Chem 1001 or Chem 1004; given at Itasca)
Field examination of succession, soils, silvical characteristics, tree classification, stand structure, and the ecology of regeneration.

3102. SOUTHERN FOREST RESOURCE TOUR. (1 cr; prereq jr or sr or #; offered alt yrs)
One-week tour of selected southern forest industries and public forest management agencies. Walnut production, southern pine silviculture, hardwood utilization, various mill tours. Discussions, paper.

3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS. (2 cr; prereq Phys 1001, Phys 1005 or #)
Fundamentals of meteorology and climatology as applied to wildland resource management.

3104. FOREST ECOLOGY. (3 cr; prereq Itasca session)
Ecological concepts and principles as a basis for silvicultural practice. The forest as an ecosystem.

3201. FIELD FOREST MEASUREMENTS. (1 cr; prereq Math 1008; given at Itasca)
Introduction to land survey, tree and stand measurement, and basic forest sampling techniques.

3225. DIRECTED STUDY EXPERIENCE. (1-5 cr; prereq #)
Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consulation with the advisor for the project, a prospectus, and completes progress reports on his or her project.

3232. MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq #)
Recreational use of the forest and associated land and water. Policy problems arising form recreational demands.

3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr; also offered as FR 5200)
International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies.

3300. ELEMENTS OF SURVEYING. (2 cr; prereq Math 1008 or high school trigonometry; given at Cloquet Forestry Center 1 week prior to fall quarter)
Basic concepts of elementary plane surveying for use in natural resource assessment. Introduction to public land and boundary surveys and geographic information systems. Lectures and labs.

5100. SILVICULTURE. (3 cr; prereq Itasca session, 1100)
Introduction to silvics, forest regeneration and site preparation techniques, intermediate silvicultural practices, and silvicultural systems.

5101. FIELD SILVICULTURE. (3 cr; prereq 5100; given at Cloquet)
Regeneration surveys, plantation inspection, site preparation, and reforestation prescription. Practice in marking for thinning and determining effect on stands. Compartment examination and prescription. Written and oral reports.

5103. ADVANCED FOREST TREE BIOLOGY. (3 cr; prereq FR 3104)
Current applications and research in forest tree biology.

5106. SENIOR SILVICULTURE SEMINAR. (2 cr [3 cr with research paper]; prereq senior, FR 5100, or #; A-N only)
Students prepare, present, and critique seminars on silvicultural topic of interest. Guest speakers.

5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS. (3 cr; prereq Stat 3011 and AgEt 3030 or equiv)
Use of microcomputer software to solve forestry problems, applications programming, working of hardware components. Hands-on access to microcomputers as well as lectures.

5114. FOREST HYDROLOGY. (3 cr; prereq Itasca session, 3103, Geo 1001 or #)

Introduction to the hydrologic cycle and hydrologic processes. Effects of forest management activities on water yield, storm flow, and water quality.

5115. FOREST HYDROLOGY, FIELD APPLICATIONS. (2 cr; prereq 5114 or #; given at Cloquet)

Use of hydrologic instrumentation to measure precipitation, streamflow, infiltration capacity, soil moisture, air temperature, evaporation, and selected water quality constituents. Collection and interpretation of hydrologic information to evaluate forest-use impacts on water quantity and quality.

5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS. (4 cr; prereq Chem 1001 or 1004, 10 cr Biol)

Genetic variation in forest trees, underlying causes, use. Tree growth, nutrition, and water relation. Environmental and internal regulation of growth. Plant biochemistry and photo-chemistry. Physiology related to silviculturally and ecologically significant phenomena.

5121. TREE PHYSIOLOGY LABORATORY. (1 cr; prereq 5120 or #)

Laboratory study of aspects of tree biology. Emphasis on design and conduct of experiments.

5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS. (2 cr; prereq 1122, 5100; given at Cloquet)

Field examination of forest soils and their relationship to site productivity and forest management.

5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS. (2 cr; prereq grad or #)

Provides an introduction to the application of Geographic Information Systems (GIS) to natural resource and regional planning studies. Theory and technical points covered, emphasis on applications. Hand-on experience on microcomputer. Case study is performed, including map digitizing, data processing, and generation of map products.

5140. APPLICATION OF SILVICULTURE IN NORTH AMERICAN FOREST TYPES. (3 cr; prereq FR 5100 or #)

Current regeneration methods and intermediate stand treatments. Economic and biological principles. Primarily lectures. Student presentations, discussion of current literature, and field trips may also be included, depending on enrol

5152. FOREST GENETICS. (3 cr; prereq sr or #)

Genetic variation of forest tree species and underlying principles; application of plant breeding principles to forestry.

5153. ADVANCED FOREST HYDROLOGY. (4 cr; prereq 3220, 5114 or #)

Current hydrologic problems in the management of forested watersheds. Analytical methods to evaluate effects of vegetation managment on the quantity and quality of runoff. Lecture and laboratory.

5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS. (3 cr; prereq grad only; offered at Itasca)

Plant identification, plant dynamics, land survey, tree measurement.

5200. AERIAL PHOTO INTERPRETATION. (3 cr)

Types, characteristics, procurement, preparation, viewing, and interpretation of color, black-and-white, and color infrared aerial photographs; basic aerial photography; introduction to mapping; applications to resource surveys.

5212. NATURAL RESOURCES INVENTORY. (3 cr; prereq Itasca session, AgET 3030 or equiv computer programming course with FORTRAN or BASIC language, Math 1142 or Math 1211, Stat 3011 or Stat 5021)

Measurement of stand variables, forest products, forest growth and yield. Elementary statistics. Sampling methods for estimating characteristics of natural resources and resources use for management decision making. Lecture and laboratory.

5215. FOREST FIRE MANAGEMENT. (2 cr; prereq FR 1100, Itasca session, 3103, 5100, or #)
Concepts, principles, and techniques of fire control and use in wildland management.

5216. SPECIAL TOPICS IN FOREST FIRE MANAGEMENT. (cr ar; prereq FR 5215 or #)
Independent study in selected aspects of forest fire management.

5217. FIELD TECHNIQUES FOR PRESCRIBED BURNING. (1 cr; prereq FR 5215 or #)
Field exercises in prescribed burn planning and execution.

5218. FIELD TECHNIQUES FOR FOREST FIRE CONTROL. (1 cr; prereq FR 5215 or #)
Supervised experience in presuppression and suppression activities.

5220. REMOTE SENSING, FOREST RESOURCES INVENTORY. (4 cr; prereq FR 5200, 5212; given at Cloquet)
Use of aerial photographs in property boundary location; interpretation and classification of forest vegetation types. Application of sampling methods for estimating natural resources and resource use for management decision making.

5226. FOREST ECONOMICS AND PLANNING. (5 cr; prereq FR 5212, AgEc 1030 or #)
Conduct and interpretation of economic analysis, forest planning concepts, principles and techniques of forest regulation.

5231. RANGE MANAGEMENT. (3 cr; prereq Biol 1103 or #)
Important range plants; range livestock; range management methods and improvements; public grazing land administration; relationship of livestock grazing to wildlife, forest, watershed, and recreation management on public and private range lands.

5233. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING. (4 cr; prereq 5232 or #) (Same as LA 5010)
For advanced students associated with design, management, and planning of recreational facilities. Planning and design principles related to recreational land use and development; parks campsites, water areas, highways, summer and winter recreational facilities.

5236. FOREST RECREATION PLANNING. (1 cr; prereq 5232; given at Cloquet)
Recreation area and site planning, examples and managerial concerns. Field work and presentation.

5240. NATURAL RESOURCE POLICY AND ADMINISTRATION. (3 cr; prereq sr in forestry or #)
Basic concepts of political and administrative processes in development of natural resource policies and programs. Policy processes, agenda setting, political decision rules, strategies for achieving agreement, participants in policy development, public means of implementing policies and case examples.

5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES. (3 cr; prereq FR 5240 or #)
Advanced concepts of political and administrative processes important to the development of natural resource policies and programs. Issue creation and agenda setting theories, incremental decision-making styles, role of analysis and analytical information, actions of major policy participants (e.g., courts, legislatures, interest groups, media), program planning, budgeting and staffing, and evaluation of natural resource case studies.

5248. HARVESTING AND ENGINEERING. (3 cr; prereq CE 3100; given at Cloquet)
An introduction to harvesting systems, relationship to forest management, and preparation and administration of timber sales. Fundamentals of location, construction, and maintenance of forest roads.

5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr)
International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies. Term paper, other requirements.

5253s. FOREST BIOMETRY. (3 cr; prereq 5212, Stat 5022 or #; offered alt even yrs)
Topics in forest measurements, sampling, inventory, and the modeling and analysis of forest growth and change.

5255s. FOREST RESOURCES SURVEY DESIGN. (3 cr; prereq FR 5212, Stat 5022 or #; offered alt odd yrs)
Advanced forest measurements, sampling, and survey design concepts and practices.

5257. RECREATION LAND POLICY. (3 cr; prereq 5232 or #)
Policy issues affecting the use and management of lands devoted entirely or in part to recreational objectives.

5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR. (3 cr; prereq 5232, RRM major or grad student or #)
Development of environmental framework for understanding recreation behavior. Contributions of several disciplines, current cultural trends, management implications.

5262. REMOTE SENSING OF NATURAL RESOURCES. (4 cr)
Introduction to remote sensing for natural resource inventories, land use analyses, and environmental monitoring activities; photographic, thermal, multispectral, and radar sensing procedures; airborne and satellite systems; visual and computer-assisted analysis techniques; oriented toward an interdisciplinary audience.

5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT. (3 cr; prereq FR 5212, 5226 or #)
Forestry applications of quantitative techniques in allocation and other decision-making problems. Mathematical programming, simulation, and other techniques.

5269. INTERDISCIPLINARY SEMINAR I. (4 cr)
Resource and community development analysis, implications for resource allocation. Selected speakers, readings, and discussion topics. Diverse disciplinary contributions reflected.

5270. INTERDISCIPLINARY SEMINAR II. (4 cr)
Development of ability to identify and analyze resource development problems. Student participation as team members; guest speakers. Diverse disciplinary contributions reflected.

5401. SENIOR TOPICS. (ar cr; prereq sr in forestry or #)
Independent study in a field of interest to the student. Work must be planned with a forestry faculty member.

5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION. (3 cr; offered through CEE)
Intended for elementary school teachers. Study of soil, water, forest, and wildlife resources of Minnesota and the biological principles and ecological implications of management.

5406. FORESTRY WORKSHOP FOR TEACHERS. (3 cr)
Forest ecosystems and forest management studied in lecture and laboratory sessions conducted in a forest environment. In field exercises, techniques and materials are developed for teaching principles of forestry in indoor and outdoor classrooms. Tours to forest and wildlife research and management units and utilization locations, and discussions of contemporary forestry issues by guest lecturers. Offered at Cloquet Forestry Center (1 week) in June.

5408. FORESTRY IN THE URBAN ENVIRONMENT. (3 cr; prereq student teacher, teacher or #)
Study of forest ecosystems and forest management in lecture and laboratory sessions. Field exercises emphasize techniques and materials useful for teaching principles of forestry in indoor and outdoor classrooms; forest areas in the Twin Cities used for field exercises. Special uses and problems of the urban forest. Discussions and presentations by guest lecturers on contemporary forestry issues.

5412. ADVANCED REMOTE SENSING. (4 cr; prereq FR 5262 or #)
Working knowledge of quantitative remote sensing. Both theoretical basis and practical aspects, including energy-matter interactions, radiation measurements and sensors, and digital analysis.

5458. WATER QUALITY MANAGEMENT: ECOSYSTEM APPROACHES. (4 cr; prereq Chem 1005, 3103 or #)
Anthropogenic influences on aquatic ecosystems. Influences include forest management, point and non-point pollution, and acid rain. Fishery impacts.

5500. URBAN FOREST MANAGEMENT. (3 cr; prereq 5100 or #)
Discussion and development of basic concepts. Introduction to terminology and principles of urban tree inventory, propagation, and care; management case studies; equipment operation and costs.

5700. COLLOQUIUM IN FOREST BIOLOGY. (1-2 cr; prereq varies with topic or #)
Colloquium on specialized topics in forest biology and silviculture.

8100. RESEARCH PROBLEMS: SILVICULTURE. (ar cr)

8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY. (ar cr)

8102. RESEARCH PROBLEMS: FOREST TREE GENETICS. (ar cr)

8103. RESEARCH PROBLEMS: FOREST HYDROLOGY. (ar cr)

8105. ADVANCED FIELD SILVICULTURE. (3 cr; prereq FR 5101, #)
Selected current problems and research in silviculture. Plant-soil relationships with particular reference to forest soils. Methods of forest soil investigations in the field and laboratory.

8106. TOPICS IN SILVICULTURE—FOREST SOILS. (ar cr; prereq FR 5100 and 5 cr in soils or #)

8200. RESEARCH PROBLEMS: FOREST MANAGEMENT. (ar cr)

8201. RESEARCH PROBLEMS: FOREST ECONOMICS. (ar cr)

8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS. (ar cr)

8203. RESEARCH PROBLEMS: FOREST RECREATION. (ar cr)

8204. RESEARCH PROBLEMS: FOREST POLICY. (ar cr)

8205. RESEARCH PROBLEMS: REMOTE SENSING. (ar cr)

8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq FR 5233, EBB 3004 or #)
Relationship of people as recreationists to the natural environment. Principles of manipulation of plant and animal communities for outdoor recreation objectives. Lectures, readings, discussions, reports, field trips.

8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS. (3 cr; prereq #)
Public and private forestry projects; analysis of commercial profitability and application of benefit-cost analysis; preparation of feasibility studies; case studies.

8210. RESEARCH METHODS IN FORESTRY. (1 cr)
Procedures for writing study plans and grant proposals. Each student will prepare study plan or grant proposal.

8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES. (3 cr)
Identification and analysis of major international, national, and state issues of importance to natural resource management. Review of literature, case studies, and guest speakers.

8213. TOPICS IN WILDLAND HYDROLOGY. (3 cr; prereq 5114, CE 5405 or #; offered alt yrs)
Lecture and discussion of current literature on the water resources of wildlands (non-urban, non-agricultural lands).

GENETICS AND CELL BIOLOGY (GCB)

College of Biological Sciences

250 Biological Sciences Center, 624-3003
Kathleen Peterson, 233 Snyder Hall, 624-9717

3002. HUMAN GENETICS, SOCIAL AFFAIRS. (3 cr [4 cr with paper], §3022, §Biol 1101, §Biol 5003; for students not directly related to biological sciences)

Human genetics; study of individuals, families, populations, and races with respect to differences in intelligence, behavior, disease, and other matters of social concern.

GEOGRAPHY (Geog)

College of Liberal Arts

414 Social Sciences, 625-6080
R. Skaggs, 568 Social Sciences, 625-6643

1401. PHYSICAL GEOGRAPHY. (5 cr; §NSci 1501)

Distribution patterns of climate, relief, vegetation, and soils, regional differences in problems of physical development.

1425. INTRODUCTION TO METEOROLOGY. (4 cr; §Soil 1262)

(Same as Soil 1262) The atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns, meteorological instruments and observation; plotting and analysis of maps; forecasting.

3343. LAND USE AND STATE GOVERNMENT. (4 cr; prereq 3344)

How individuals choose to use land in the United States; the state's role in such choices. Descriptions of American landscapes as outcomes of decisions.

3344. LAND USE AND THE FEDERAL GOVERNMENT. (4 cr)

Analysis of how individuals choose to use land in the United States, emphasizing the statutory and regulatory framework for decisions. Description of American landscapes as outcomes of decisions.

3345f. ENERGY AND MINERALS. (4 cr)

Sources, production, circulation, and consumption of power, metals, and nonmetallic minerals. Problems of exhaustion, substitution, pollution, costs, trade, and policy. National and local case studies.

3351. FOOD PRODUCTION AND DISTRIBUTION. (4 cr)

Environmental constraints on agriculture, agricultural decision making, farming systems, contemporary issues in the U.S., and international food production and distribution.

3421. CLIMATOLOGY. (4 cr; prereq 1401 or #)

World distribution of climatic elements; methods of arranging climatic data; climatic classifications and world distributions of climatic types; general circulation; climatic change and climatic fluctuations.

3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY. (4 cr; not open to biology majors)

World distribution of plants and animals; biological and ecological background; the geographical picture; the paleoecological record.

3441f. LANDFORM GEOGRAPHY. (4 cr)

The role of landforms in the distribution of resources; processes of landform origin and change; map interpretation of landforms; complex environmental history of the Quaternary period and its contribution to a complicated pattern of landforms, with emphasis on North America.

3451. GEOGRAPHY OF SOILS. (4 cr; §Soil 5512)

Distributions of soil-forming processes and soil types; soil differences in small areas; soil constraints on human activities in different places; regional differences in soil problems and management techniques—farming, forestry, construction, agri-business, suburbanization, homesteading.

5344. HISTORICAL GEOGRAPHY OF RESOURCE USE IN THE UNITED STATES. (4 cr; prereq 3101 or 3344 or grad)

Selected topics in the development of the American landscape; how resources have been used.

5423w. ADVANCED CLIMATOLOGY. (4 cr; prereq 3421 or #)
Selected topics including energy balances, synoptic climatology, climate models.

5424. APPLIED CLIMATOLOGY. (3 cr; §Soils 5424; prereq Geog 3421 or Soils 5420 or #)
Application of climatic principles and data to selected problems in environmental management and agriculture.

5444. GEOGRAPHY OF WATER RESOURCES. (4 cr; prereq two courses in physical geography or #)
Distributional aspects of the magnitude, quality, and dynamics of water resources. Aesthetic, recreational, and material production uses of water; consequences of human actions in the hydrosphere, expecially in fresh water.

8340. SEMINAR: LAND USE PLANNING. (3 cr; prereq #)

8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (1 cr; prereq #)

8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (3 cr; prereq 8344)

8420. SEMINAR: CLIMATOLOGY. (1-3 cr; prereq #)
Detailed study of selected topics. Topics vary from year to year; examples include modeling, climatic variability, predictability, severe local storms, drought, and energy balance.

GEOLOGY AND GEOPHYSICS (Geo)

Institute of Technology

106 Pillsbury Hall, 624-1333
H.O. Pfannkuch, 2D Pillsbury Hall, 624-1620

1001f,w,s. PHYSICAL GEOLOGY. (4 cr; 4 lect hrs)
A nonmathematical introduction to earth, its internal structure; processes that shape its surface; theory of plate tectonics; action of streams, glaciers, waves, wind, and groundwater; limnology; fossil fuels and mineral deposits; environmental geology; planetary geology;and the geology of Minnesota.

1005w. GEOLOGIC PERSPECTIVES ON ENERGY. (4 cr; 4 lect hrs per wk)
Introduction to the geologic aspects of energy resources, conventional and unconventional. History of energy use, distribution and amounts of known and potential reserves, environmental aspects and implications of U.S. consumption patterns.

1012f. INTRODUCTION TO COMPARATIVE PLANETOLOGY. (4 cr)
A nonmathematical introduction to comparative planetology. Topics include the origin and evolution of the solar system, composition, structure, and dynamics of planetary interiors, planetary surfaces, oceans and atmospheres; plate tectonics, the origin of the elements, climate, Earth resources, the biosphere, the life cycle of stars, vulcanism, and measurement of geologic time.

1021f,w,s. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA. (1 cr; prereq 1001 or ¶1001 or #; one 2 hr lab)
Ten laboratory exercises based on the geology of Minnesota. These labs will introduce students to the bedrock, glacial history, topography, mineral resources, and environmental geology of the state through the use of appropriate minerals, rocks, topographic and geologic maps.

1111s. INTRODUCTORY PHYSICAL GEOLOGY. (5 cr; prereq high school or college chemistry or #; 3 lect hrs, 1 rec hr, and two 2-hr labs per wk)
For prospecitve majors and others desiring a more intensive course.

1601w. OCEANOGRAPHY. (4 cr; 3 lect and 1 lab hrs per wk)
How various processes in the ocean interact; analogies between the oceans and Lake Superior and smaller lakes in Minnesota. Topics include marine biology, waves, tides, chemical oceanography, marine geology and human interaction with the sea. Lab work includes study of live marine invertebrates and manipulation of oceanographic data.

3401w. INTRODUCTORY MINERALOGY. (5 cr; §5004, 5404; prereq 1001 or 1111 or #, 1 term college chemistry, Math 1221; 3 lect and 6 lab hrs per wk)

Crystallography, crystal chemistry, and crystal physics. Physical and chemical properties, crystal structures, and chemical equilibria of the major mineral groups. Laboratory includes crystallographic, polarizing microscope, X-ray powder diffraction exercises, and hand specimen mineral identification.

5004w. MINERALOGY. (4 cr; §3401; not open to geology, geophysics, and geological or mineral engineering majors; prereq Math 1221, 1 term college chemistry, and #; 3 lect and 6 lab hrs per wk; offered when demand warrants)

For description, see 3401.

5108w. ADVANCED ENVIRONMENTAL GEOLOGY. (4 cr; prereq geology core courses 1111 through 5201 or equiv or #)

Human impact on the geological environment and the effect of geology; geologic processes on human life from the point of view of ecosystems and biogeochemical cycles. Geologic limits to resources and carrying capacity of the earth. Land use planning, environmental impact assessment, ecogeologic world models. Field project.

5201s. STRUCTURAL GEOLOGY. (5 cr; prereq 3401; 3102; IT: upper division major in Geo, Geophys, GeoE, MinE; CLA: jr or sr GEO major; or #)

Primary and secondary structures of rocks, mechanics and modes of deformation, introduction to field methods in geology. Field trips.

5251. GEOMORPHOLOGY. (4 cr [5 cr with term project]; prereq 1001, Math 1111 or #; 3 lect, 2 lab hrs per wk; lab often used for field trips; offered when demand warrants)

Study of the origin, development, and continuing evolution of landforms in various environments. Environmental implications are emphasized. Topics include weathering, slope and shore processes, fluvial erosion and deposition, wind action, tectonics, and impact phenomena.

5261. GLACIAL GEOLOGY. (4 cr [5 cr with term paper or map lab]; prereq 1002 or 3112; offered when demand warrants)

Formation and characteristics of modern glaciers; erosional and depositional features of Pleistocene glaciers; history of Quaternary environmental changes in glaciated and nonglaciated areas. Field trips.

5601f,w. LIMNOLOGY. (4 cr; §EBB 5601; prereq Chem 1005 or equiv)

Description and analysis of events occurring in lakes, reservoirs, and ponds, beginning with their origins and progressing through study of their physics, chemistry, and biology. Emphasis on interrelationships of these parameters and on effects of civilization on lakes.

5611s. GROUNDWATER GEOLOGY. (4 cr; prereq 1001 or 1111; Math 1231, 1 qtr physics and chemistry or #)

Origin, occurrence, and movement of groundwater viewed in the context of the hydrologic cycle. Characteristics of aquifer systems. Exploratory investigations. Hydrogeologic units and boundaries of regional systems. Analysis of surface water-groundwater interaction, recharge. Quality and chemistry of groundwater supplies. Contaminant hydrology.

8262. QUARTERNARY PALEOECOLOGY AND CLIMATE. (4 cr; prereq 5261 or #; offered when demand warrants)

Principles of stratigraphic pollen analysis. Pleistocene and Holocene vegetation and climatic history as interpreted from pollen diagrams from different parts of the world. Paleoclimatic interpretation of ocean-sediment cores.

8602w. ADVANCED LIMNOLOGY. (3 cr; prereq 5601 or equiv, #; offered 1987-88 and alt yrs)

Detailed study of selected problems in limnology using current and classical literature. Term paper required.

8611. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA. (2 or 3 cr; prereq CE 3400 or Chem 5520 or equiv or #; 2 lect hrs per wk and term project ar; offered when demand warrants)

Microscopic flow parameters, momentum, mass and energy transport through porous media, rate processes, coupled processes and nonequilibrium thermodynamics, geologic controls of natural flow systems in porous media and aquifers.

8612. ANALYTICAL GEOHYDROLOGY. (3 cr; [4 cr with term paper]; prereq Math 3221, CE 3400 or #; offered when demand warrants)
Microphysics of flow through porous media; geological factors in aquifer performance; equations for groundwater flow; analysis of pumping tests; potential theory in groundwater flow; computer and analog models of aquifers; groundwater basin analysis; contaminant fate and transport through aquifers.

HISTORY OF SCIENCE AND TECHNOLOGY (HSci)

Babbage Institute for History of Information Processing

103 Walter Library, 624-5050
Arthur Norberg, 103 Walter Library, 624-5050

5311w. TECHNOLOGY IN AMERICAN LIFE AND THOUGHT. (4 cr)
Technology in America with emphasis on its impact on society and culture. Traces the growth of American technology in its cultural and intellectual context from colonial period to present.

HUMANITIES (Hum)

College of Liberal Arts

314 Ford Hall, 624-5553
W. John Archer, 310 Ford Hall, 624-5553

3663. IDEAS OF NATURE: ENGLAND AND AMERICA TO 1875. (4 cr; prereq jr or sr or #)
Nature in Anglo-American culture. Seventeenth-century ordered universal hierarchy and Puritan "garden in the wilderness," aesthetics of the sublime and picturesque, 19th-century romanticism and transcendentalism. Shaftesbury, Wordsworth, Thoreau, Hawthorne, Muir; clerics, philosophers, aestheticians, painters, poets, novelists, explorers.

INSTITUTE OF TECHNOLOGY (IT)

105 Walter Library, 624-2006
M. T. Hepworth, Mineral Resources Research Center, 56 East River Road, 625-6354

3103s. INDUSTRIAL SOLID WASTE CHARACTERIZATION AND RECOVERY. (4 cr; prereq Chem 1003 or equiv)
This course is part of a Five-College Cooperative Curricular Project on "Garbage, Government, and the Globe". Students are encouraged to register for more than one course to broaden their perspectives on the topic. For the other four courses, see: Biol 3052, BGS 3019, Pol 3970, and Soil 1020. During spring quarter, students registered for these courses will also participate in a joint seminar. Types and sources of solid wastes, especially those with potential values (e.g. cement, fertilizer, fuel, or metals) will be examined. Particular attention will be directed to solids generated by incinerators, power plants, municipal water treatment plants, electroplaters and electric furnace steel producers. Effort will be directed also towards methods of detoxification, recovery and reuse.

INTERDEPARTMENTAL STUDY (ID)

College of Liberal Arts

225 Johnston Hall, 624-5701
Mary Lymer, 225 Johnston Hall, 624-5701

3970. DIRECTED STUDIES. (3-15 cr per qtr; prereq OSLO [Office for Special Learning Opportunities] approval, Δ)
Individual readings and research on topics that cross departmental lines.

JOURNALISM AND MASS COMMUNICATION (Jour)

College of Liberal Arts

111 Murphy Hall, 625-9824
P. Tichenor, 35 Murphy Hall, 625-7261

5133. INTERPRETIVE REPORTING ABOUT SCIENCE. (4 cr; prereq 3121 or #, Δ; offered 1989-90)

Role of journalistic communication in science; scientist-journalist relationships; communicating results of scientific investigations to public, specialized audiences, industry.

5143s. INTERPRETATION OF SCIENCE AND TECHNOLOGY. (4 cr; prereq 5133 or #, Δ)

Analysis of scientific research and technological development for mass and specialized media; critical study of science content in media; audience impact.

LANDSCAPE ARCHITECTURE (LA)

Institute of Technology

205 North Hall, 625-8285
David Pitt, 205 North Hall, 624-2205

1021. HISTORY OF ENVIRONMENTAL DEVELOPMENT: ARCHITECTURE. (4 cr; Arch 1021; 4 lect hrs per wk)

Introduction to the philosophy and principles of architecture and landscape architecture as an art; survey of environmental history from the ancient periods through the medieval age.

1022. HISTORY OF ENVIRONMENTAL DEVELOPMENT: LANDSCAPE ARCHITECTURE. (4 cr; Arch 1022; prereq 1021; 4 lect hrs per wk)

Continuation of 1021 from the Renaissance through the modern eras; focuses on forces and individuals that shaped the form of architecture and landscape architecture in the 19th and 20th centuries in America and Europe.

1023. HISTORY OF ENVIRONMENTAL DEVELOPMENT: PLANNING. (4 cr; Arch 1023; prereq 1022; 4 lect hrs per wk)

Introduction to urban planning. Survey of the rise and history of cities as centers of civilization. Collaboration among various disciplines for creating better urban environment and improving the quality of human life in cities.

1031. INTRODUCTION TO LANDSCAPE ARCHITECTURE. (4 cr; 4 lect hrs per wk)

Design potential of materials of the landscape; exercises in assessment of land developments and detail landscapes; the role of landscape architecture in shaping the natural and cultural environment; brief historical review of site developments.

3001. ENVIRONMENTAL DESIGN: PEOPLE AND ENVIRONMENT. (4 cr; Arch 3001)

Interaction of people with the environment, using natural and social sciences and the arts as background for readings, lectures, discussions, and workshop sessions.

3002. ENVIRONMENTAL DESIGN: TOOLS AND PROCESSES. (4 cr; Arch 3002; prereq 3001)

Nature and the effects of various tools and processes of environmental change, ranging from buildings and landscapes to economic policies, climate, and myths. Readings, lectures, discussions, and workshop sessions.

5010. PRINCIPLES OF OUTDOOR RECREATION DESIGN AND PLANNING. (4 cr; §FR 5233; 4 lect hrs per wk)

For advanced students interested in design, management, and planning of recreational facilities. Planning and design principles related to recreational land use and development; parks, collection, storage, treatment, and disposal. Utilization of liquid and solid wastes. Non-urban water supply and quality.

5099. RCD INTERDISCIPLINARY SEMINAR I. (4 cr; 5099-5100†)

Selected speakers, readings and discussion topics dealing with resource and community development analysis and implications for resource allocation. Students participate as a team, combining disciplinary skills to analyze complex resource development problems.

5100. RCD INTERDISCIPLINARY SEMINAR II. (4 cr)
Continuation of 5099.

5105. RECREATIONAL PLANNING AND DESIGN. (6 cr; prereq 5010; 2 lect and 12 lab hrs per wk)
Analysis, development, and presentation of landscape design solutions for diverse, recreational land uses.

5107. REGIONAL LANDSCAPE DESIGN.
(6 cr; prereq senior or grad or #)
Emphasis on large-scale land areas. Analyzing development potential and evolving solutions for integration of such divergent land use patterns as agricultural, residential, commercial, industrial and recreational.

5562. INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS. (4 cr; prereq jr, sr, or grad major in Geog or LA or #)
Basic concepts of geographic information systems structure. Theory and applications for landscape location and resource analysis, and regional planning. Location principles, data structure, and variable attributes.

8330. CONCEPTS OF LANDSCAPE EVALUATION. (2 cr; prereq 8108, MLA student or #)
Studies in philosophical bases for and wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors.

8390. DESIGNING THE LONG-TERM LANDSCAPE. (2 cr; prereq MLA student or #)
Problems of designing landscapes that must sustain their integrity over generations or centuries. Survey of historical examples. Design theory, principles, and strategies.

LAW SCHOOL (Law)

285 Law Building, 625-1000
Steven H. Goldberg, 381 Law, 625-8536

5201. LAND USE PLANNING. (3 cr; offered 1989-90)
Public control of land use and development, and eminent domain.

5215. ENVIRONMENTAL LAW. (3 cr; offered 1989-90)
Legal aspects of major environmental problesm with emphasis upon pervasive issues that reappear in various regulatory contexts: e.g., the degree to which environmental quality should be protected; who should bear the cost enhancing environmental quality; the allocation of responsibilities among courts, legislatures, and administrative agencies; the role of citizens' groups and environmental litigation.

MANAGEMENT (Mgmt)

School of Management

30 Management and Economics, 625-0027
A. Marcus, 830 Management and Economics, 624-2812

8019. MANAGEMENT TOPICS: BUSINESS, THE PHYSICAL ENVIRONMENT, AND NATURAL RESOURCE ISSUES. (3 cr)
The impacts of business on the natural environment are very great. These impacts are both national and international in nature. Subsequent social, legal, and economic reactions to these environmental impacts may have consequences not only for an individual firm's profitability and survival, but also for global competitiveness and economic development. Solutions to environmental problems range from moral appeals and voluntary assumption of corporate responsibility to government regulation and government-imposed incentive strategies. This course will examine the reciprocal impacts of the firm and environmental/natural resource issues and will investigate various possible solutions to business-related environmental problems. It will focus on how companies cope with these issues, assessing both the role of internal corporate functions and of corporate external relations and stakeholder management.

MECHANICAL ENGINEERING (ME)

Institute of Technology

125 Mechanical Engineering, 625-0705
B.Y. Liu, 130 Mechanical Engineering, 625-6574

5402. ECOLOGY, TECHNOLOGY, AND SOCIETY. (4 cr; §SSci 3402; prereq IT student or grad; 4 lect hrs per wk)

Dilemmas produced as a result of conflicts between finite limits and population and industrial growth; underlying causes; current technology, values, economics, institutions, and political structures; and possible directions for resolution. Faculty members from various disciplines participate.

5603. THERMAL ENVIRONMENTAL ENGINEERING. (4 cr; prereq IT student or grad, 3303 and 5342 or equiv; 4 lect hrs per wk)

Thermodynamic properties of moist air; h-W diagram for moist air; solar radiation; heat and water vapor transmission in structures; effects of thermal environments upon people, processes, and materials; thermal loads, thermal environmental control systems.

5607. INDUSTRIAL VENTILATION AND CONTAMINANT CONTROL. (4 cr; prereq IT student or grad, 3303 and CE 3400 or equiv; 4 lect hrs per wk)

Contaminants, dispersion mechanisms, transport, fans, hoods, gas cleaners, behavior of jets and sinks, closed and open systems, applications to industrial processing and emission control.

5609. AIR POLLUTION. (4 cr; prereq IT student or grad, 3303 or #; 4 lect hrs per wk)

Air pollution sources, atmospheric transport, transformations and fate. Air pollution meteorology, dispersion, and models. Basic chemistry of secondary pollutant formation, aerosol growth, air pollutant visibility relationships. Standards and regulations.

5612. ENVIRONMENTAL ENGINEERING. (4 cr; prereq IT student or grad, 3303; 4 lect hrs per wk)

Basic principles of engineering assessment and control of emissions to air and water; noise measurement and control; and control, handling, and disposal of solid waste.

5712. SOLAR ENERGY UTILIZATION. (4 cr; prereq IT student or grad, 5342 or #; 4 lect hrs per wk)

History and potential of solar energy utilization; availability of solar radiation on clear and cloudy days; incident radiation on horizontal, vertical, and inclined surfaces; flat-plate and concentrating solar collectors; heating and cooling with solar energy; power generation; review of current research.

MICROBIOLOGY (MicB)

College of Biological Sciences, College of Liberal Arts, and Medical School

1460 Mayo Memorial Building, 624-6190
Palmer Rogers, 1015 Mayo Memorial Building, 624-5177

3103f. GENERAL MICROBIOLOGY. (5 cr; §5105, §Biol 5013, §VPB 3103; prereq soph with C avg in courses prereq to major sequence, or jr with 10 cr chemistry and 5 cr biological sciences or #)

Morphology, physiology, taxonomy, and ecology of bacteria. Applications of fundamental principles. Lab.

5352s. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #)

Microbial adaptation to various environments; role of microorganisms in the earth's biogeochemical cycles. Application of microbial systems to industrial processes; basic principles of fermentation technology; microbial bioconversions and product formation. Biodegradation of chemicals.

NATURAL RESOURCES AND ENVIRONMENTAL STUDIES (NRES)

College of Agriculture and College of Natural Resources

439 Borlaug Hall, 625-1244
T. H. Cooper, 439 Borlaug Hall, 625-7747

1010s. ISSUES IN THE ENVIRONMENT. (3 cr)

Interdisciplinary offerings exploring five areas of environmental concern: aspects of environmental design that provide maximum compatibility of human beings with their environment, sources of water pollution and their control, disposal and control of solid wastes from agriculture, minimization of pesticide pollution of the environment, and managed use of forest resources to maintain environmental quality. A televised course involving 20 taped lectures and 10 discussion periods.

PHYSICS (Phys)

Institute of Technology

148 Physics, 624-7375
K. Maversberger, 42 Physics, 624-6305

1071f. INTRODUCTORY METEOROLOGY. (4 cr; prereq high school algebra; 4 lect hrs per wk)

Physics of atmospheric processes. Clouds, fronts, and cyclones. Weather forecasting. Human influence on the atmosphere.

1075f. INTRODUCTORY METEOROLOGY LABORATORY. (1 cr; S-N only; prereq 1071 or ¶1071; 2 lab hrs per wk)

Field experiments offered in conjunction with 1071.

5461w. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE. (4 cr; prereq general physics and calculus)

Survey of atmosphere above 15 km; physics and chemistry of the stratosphere, mesosphere, and thermosphere; temperature and density profiles; major and minor constituents and their distributions; aspects of pollutants; reactions and rates; global variation of constituents; the energy budget of the atmosphere.

PLANT BIOLOGY (PBio)

College of Biological Sciences

220 Biological Sciences Center, 625-1234
Thomas Soulen, 220 Biological Sciences, 625-1234

1009s. MINNESOTA PLANT LIFE. (4 cr; suitable for nonmajors)

Identification of the more characteristic and conspicuous Minnesota plants, including many lower forms, with discussion of their basic distinctions, life cycles, habitat requirements, distribution, vegetation types, and ecological relations. Lectures, discussions, six field trips.

1012s. PLANTS USEFUL TO HUMANS. (4 cr; for majors or nonmajors)

Roles that plants play and have played in human biological and cultural development. Lectures and demonstrations.

3201s. INTRODUCTORY PLANT SYSTEMATICS. (4 cr; prereq Biol 1103 or 3012)

Systematics of the flowering plants of the world. The ecology, geography, origins, and evolution of the flowering plants; family characteristics; floral structure, function and evolution; pollination biology; methods of phylogenetic reconstruction; molecular evolution; taxonomic terms; methods of collection and identification. Two field trips.

5103f. ALGAE, FUNGI, AND BRYOPHYTES. (5 cr; prereq Biol 1103 or 3012; offered 1990-91 and alt yrs)

Characteristics of groups, evolutionary relationships, life cycles, comparative morphology (including ultrastructure), comparative nutrition. Laboratory emphasizes living material and isolation of algae and fungi into culture.

5231f. INTRODUCTION TO THE ALGAE. (5 cr; prereq 10 cr in botany or biology or #; offered 1989-90 and alt yrs)

Structure, reproduction, and life histories of major algal divisions.

Course Offered at Lake Itasca Forestry and Biological Station.

5801su. PLAINS AND BOREAL FLORA. (5 cr; limited to 20 students; prereq course in taxonomy, Δ; offered annually)
Survey of the summer flowering plants and ferns of the state with particular reference to the local flora. Identification by technical keys; important plant families; field recognition of common species; habitat preferences; collecting methods; literature; taxonomic methods.

PLANT PATHOLOGY (PlPa)

College of Agriculture

495 Borlaug Hall, 625-8200
Philip Larsen, 495 Borlaug Hall, 625-8200

1001f,w. INTRODUCTORY PLANT PATHOLOGY. (5 cr; 5050; prereq soph, 9 cr plant sciences)
Introductory course in plant diseases. Lectures and laboratory.

5002f,w. INTRODUCTORY PLANT PATHOLOGY FOR ADVANCED STUDENTS. (5 cr; 1001, 5050, prereq one 4 cr plant sciences or #)
Introductory course in plant diseases. Lectures, laboratory and special problems.

5007s. AIR POLLUTION AND OTHER ABIOTIC CAUSES OF PLANT DISEASE. (3 cr; prereq 20 cr biology incl biochemistry)
Lectures, assigned readings and discussions about the characteristics and effects of phytotoxic air pollutants (60%) and water, temperature extremes, soluble salts, mineral elements, allelopathy and pesticides (40%) as causes of plant disease.

5008s. INTRODUCTION TO PLANT NEMATOLOGY. (2 cr; prereq 3001, 5002)
Introduction to the characteristics, strengths and weaknesses of plant and soil nematodes achieved through study of the biology and morphology of five important genera of plant parasitic nematodes. Field and laboratory experiences in sampling, processing of soil and plant tissues, identification and counting, and control of plant nematodes.

5050s. FOREST PATHOLOGY. (4 cr; prereq 10 cr plant sciences or forestry)
Diseases of forest and shade trees; wood decay. Symptoms, etiology and control. Lectures, laboratory, and field work.

8003s. PLANT DISEASE THEORY III, POPULATIONS. (4 cr; prereq 5005, 5006, 5007 or #, and 8001, 8002)
Plant disease in populations of plants; agroecosystems, natural ecosystems, and interrelatedness of plant disease over large geographic areas. This course introduces elements of population genetics, epidemiology, and geopathology.

POLITICAL SCIENCE (Pol)

College of Liberal Arts

1414 Social Sciences, 624-4144
Undergraduate Advising Office, 1482 Social Sciences, 624-8517

3321. ISSUES IN AMERICAN PUBLIC POLICY. (4 cr)
Major public policy issues in such areas as social welfare and education; political forces molding policy choices and impact of such choices.

3970s. ETHICS AND THE ENVIRONMENT. (4 cr)
This course is part of a Five-College Cooperative Curricular Project on "Garbage, Government, and the Globe". Students are encouraged to register for more than one course to broaden their perspectives on the topic. For the other four courses, see: Biol 3052, BGS 3019, IT 3103, and Soil 1020. During spring quarter, students registered for these courses will also participate in a joint seminar. An examination of ethical aspects of environmental policies and practices against the background of two competing views of humankind's place in and relation to nature. On the one side, a "humanist" or "anthropocentric" ethic views humans as competitors with, and conquerors of, nature, and defines the good life as an affluent life in which humans make maximum use of nature's abundance. On the other, an "environmental" or "stewardship" ethic views humans as part of, and deeply

dependent on, nature, and defines the good life as one lived in harmony with the natural environment.

5523. THE POLITICS OF THE REGULATORY PROCESS. (4 cr; prereq 1001 or equiv or #)
Operations of regulatory agencies considered in context of political and legal environment. Principles of federal administrative law, informal procedures, interest group activity, philosophy of regulation, politics and processes of deregulation.

PUBLIC AFFAIRS (PA)

Hubert H. Humphrey Institute of Public Affairs

300 Humphrey Center, 625-9505
D.E. Abrahamson, 243 Humphrey Center, 625-2338

5601. LAND USE. (4 cr)
Physical, spatial basis for community and regional development. Private sector development processes. Public regulatory frameworks, guidance and interventional strategies. Integration of physical, social and economic factors in land use policy, planning and decision-making. Graduate status or written permission.

5622. DEVELOPMENT MANAGEMENT SYSTEMS. (3 cr)
Integrated systems of controls and incentives to manage land development at state, metropolitan, and local government levels. Traditional planning and land use devices, tax and fee techniques, environmental regulations and innovative controls.

5701, 5702. TECHNOLOGY PLANNING I AND II. (3 cr each)
Relationship of science and technology to ideological bases of our society; identification of technology's significance to the policy process; analysis of our society's institutions for governing its technologies.

5711. ENERGY POLICY I. (3 cr)
Possible energy supply systems and ways energy is consumed; relatively non-technical description of physical systems, environmental and social impacts, regulatory frameworks, resource base, and relationship to energy policy options.

5712. ENERGY POLICY II. (3 cr)
Energy policy options including political, economic, environmental, and other considerations.

5721. ENVIRONMENTAL POLICY I. (3 cr)
Systems in the natural and physical environment. Environmental impacts of technological innovation. Associated social controversy. Legislative, judicial, regulatory responses.

5722. ENVIRONMENTAL POLICY II. (3 cr)
Relationship of science and technology to ideological bases of our society; identification of technology's bases of our society, identification of technology's significance to the policy process analysis of our society's institutions for governing its technologies.

8600. SEMINAR: LAND USE PLANNING. (3 cr)
Topics vary, similar to an advanced topics course.

8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr)
Advanced analysis of selected topics in land use and human settlements such as large scale planned communities, agricultural preservation, historical preservation, infrastructure planning and programming, urban transportation policy.

8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY. (3 cr)
Topics in technology, energy, and environment, such as hazardous waste, energy efficiency, nuclear technologies, or atmospheric carbon dioxide.

RECREATION, PARK, AND LEISURE STUDIES (Rec)

College of Education

203 Cooke Hall, 625-5300
Leo H. McAvoy, 209 Cooke Hall, 625-5887

5160w. CONSERVATION OF PARK RESOURCES. (3 cr; prereq 1520 or 5100 or Δ)

Environmental considerations in relation to recreation and leisure services; environmental and visitor management in park areas.

5250s. FINANCING LEISURE SERVICES. (3 cr; prereq 3550 or Δ)

Methods and techniques of financing operations and capital improvements in public park and recreation agencies and nonpublic community leisure services; sources of revenue budgeting procedures.

5300f. FOUNDATIONS OF OUTDOOR EDUCATION. (3 cr; prereq sr, 1520 or 5100 or #)

Investigation of the philosophical, historical, and educational foundations of outdoor education.

5310s. PROGRAMMING IN OUTDOOR EDUCATION. (4 cr; prereq 5300 or #)

Methods, materials and settings for outdoor education and environmental interpretation programs.

5350su. WILDERNESS OUTDOOR RECREATION PROGRAMMING. (4 cr; prereq 3150 or #)

Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

RESOURCE AND COMMUNITY DEVELOPMENT (RCD)

College of Agriculture

439 Borlaug Hall, 625-1244
Russell S. Adams, Jr., 439 Borlaug Hall, 625-4229

3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY.

See Soil 3118.

5099. RCD INTERDISCIPLINARY SEMINAR I. (4 cr; 5099-5100†, §RCD 5099, §AgEc 5099, §AgET 5099, §Soil 5099; prereq resource and community development sr or #)

Selected speakers, readings, and discussion topics dealing with resource and community development analysis and implications for resource allocation. Students participate as a team, combining disciplinary skills to analyze complex resource development problems.

5100. RCD INTERDISCIPLINARY SEMINAR II. (4 cr; 5099-5100†, §RCD 5100, §AgEc 5100, §AgEt 5100, §Soil 5100; prereq 5099 or #)

(Continuation of 5099) Papers, presentations, and critiques on selected complex resource problems in Seminar I.

RHETORIC (Rhet)

College of Agriculture

202 Haecker Hall, 624-3445

1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE. (4 cr)

American attitudes toward the land from colonial times to the present as expressed in social history, literature, and fine arts. Social thought and the relationship between farm and city, wilderness and countryside. The changing appearance of America.

SOCIOLOGY (Soc)

College of Liberal Arts

909 Social Sciences, 624-4300
Robert Kennedy, 1125 Social Sciences, 624-1615

3551w,s. WORLD POPULATION PROBLEMS. (4 cr)

Population growth and natural resources, population dynamics, fertility and mortality in less developed and industrialized nations, population forecasts, policies to reduce fertility.

SOIL SCIENCE (Soil)

College of Agriculture

439 Borlaug Hall, 625-1244
Russell S. Adams, Jr., 439 Borlaug Hall, 625-4229

1020w. THE SOIL RESOURCE. (4 cr)

This course is part of a Five-College Cooperative Curricular Project on "Garbage, Government, and the Globe". Students are encouraged to register for more than one course to broaden their perspectives on the topic. For the other four courses, see: Biol 3052, BGS 3019, IT 3103, and Pol 3970. During spring quarter, students registered for these courses will also participate in a joint seminar. Introduction into the physical, chemical, and biological aspects of soils. Use of the soil classification system to understand soil survey interpretations for land management decisions. Concepts of soil fertility for plant growth and the role of soils in environmental planning and conservation decisions. Introduction to urban soils and their management.

1262. INTRODUCTION TO METEOROLOGY. (4 cr)

(Same as Geog 1425) The atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns; meteorological instruments and observations; plotting and analysis of maps; forecasting.

3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY. (cr; S-N only; max 3 cr)

A collection of speakers addressing a current rural soil and water environmental issue, with emphasis on policies and very pertinent technical concerns, invited speakers from the University, the public, and state and federal agencies. A new topic is examined each time offered.

3125. BASIC SOIL SCIENCE. (4 cr; prereq Chem 1001 or 1004)

Basic physical, chemical, and microbiological properties of soil. Soil genesis, classification, and principles of soil fertility. Lectures and laboratory.

3225. PHYSICAL SOIL MANAGEMENT AND CONSERVATION. (4 cr; prereq 3125)

Physical characteristics of soil related to plant growth and development. Soil erosion processes, factors, measurement. Soil conservation: water and wind conservation practices (rural and urban); economic, social, and policy considerations; conservation strategies. Erosion and conservation in the world.

5104. AGRICULTURAL SYSTEMS ANALYSIS AND MODELING. (4 cr; §PlPa 5104, §AgEc 5104, §AnSc 5104; prereq Math 1142 or #)

Introduction to bioeconomic modeling as preparation for interdisciplinary agricultural systems analysis. Basic concepts; deterministic and stochastic models; delays, feedback, and clockwork; data aquisition; model verification and validation; role of models for agroecosystem management.

5240. MICROCLIMATOLOGY (SOILS). (5 cr; prereq Math 1111, 10 cr physics or #)

Meteorology and climatology in relation to the soil-atmosphere interface, with emphasis on the microclimate, physical processes taking place within the microclimate, modification of the microclimate, description of meteorological instruments, and use of weather data.

5340. ORGANIC AND PESTICIDAL RESIDUES. (5 cr; prereq 1122, sr or #)

The fate of crop residues, animal wastes, sewage materials, petroleum hydrocarbons, detergents, and pesticides in soils with emphasis on the chemical, physical, and biological factors of the soil that influence decomposition or persistence.

5424. APPLIED CLIMATOLOGY. (3 cr; prereq 5140 or Geog 3421 or #)
Intended for advanced undergraduates and beginning graduate students who have a background in the principles of climatology or microclimatology. Sources of climatic data, methods of analysis, and selected set of specific applications that focus on agricultural and environmental management problems.

5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION. (3 cr; prereq 1122 or #)
Formation, properties, and management of peatlands important to crop, forestry, and energy production in this state and worldwide. Lecture.

5560. USES AND INTERPRETATION OF SOIL SURVEY INFORMATION. (3 cr; prereq 3520 or #)
Techniques used in preparing soil maps of varying scales. Information available from soil maps and accompanying reports evaluated for use in agriculture, engineering, waste treatment, forestry, and land planning. How soil survey information can be used to the fullest extent by both lay persons and the scientific community.

5610. SOIL BIOLOGY. (4 cr; prereq 1122 and PlPa 1001 or #)
The soil environment and its biological population. Role of living organisms in the soil-plant environment and cyclic transformations of agronomic interest (carbon, nitrogen, and mineral substances). Effect of soil microflora on soil fertility and plant nutrition. Lectures and laboratory.

UNIVERSITY COLLEGE (UC)

317 Walter Library, 624-2022
Mary Mishler, 7 Wulling Hall, 624-2004

3075. INDEPENDENT STUDY. (3-15 cr; prereq Δ)
UC 3075 is an undergraduate independent study course listing available to students who wish to pursue projects that go beyond the scope of any single department or college of the University. Projects are interdisciplinary in nature or are through departments that do not have an undergraduate independent study course for non-majors. Students design their own projects and work with an appropriate faculty member who supervises and evaluates their project. May be taken for 3 to 15 degree credits.

VETERINARY BIOLOGY (VB)

College of Veterinary Medicine

295K Animal Science/Veterinary Building, 624-2700
Patrick T. Redig, 295B Animal Science/Veterinary Building 624-4969

5330. WILD BIRD MEDICINE. (2 cr; prereq regis vet med, 3rd or 4th year or DVM grad student or #)
Brief summary of important aspects of clinical avian anatomy and physiology and pathology. Survey of diseases common to wild birds and surgical repair of common injuries and fractures.

PART III. SPECIAL CENTERS, SERVICES, LIBRARIES

CENTERS AND SERVICES

JAMES FORD BELL MUSEUM OF NATURAL HISTORY

Donald Gilbertson, Director, 10 Church Street S.E., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 624-4112.

The museum maintains exhibits and public education programs on natural history and supports research in ecology, systematics, paleontology, and behavior of vertebrates. The Natural History Library emphasizes collections in vertebrate zoology, behavior, and basic ecology and is located in the museum.

The museum also houses the Field Biology Program, administered by the College of Biological Sciences. The Cedar Creek Natural History Area (located at Bethel, Minnesota) is a field resource administered by the University with assistance from the Minnesota Academy of Sciences; it is open to qualified scientists for research purposes. Information on the Lake Itasca Forestry and Biological Station summer session is available in a special University bulletin that is published each year.

CENTER FOR POPULATION STUDIES

James W. Vaupel, Director, 231 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 625-9821.

The center coordinates graduate programs in family planning administration and in population studies.

CENTER FOR URBAN AND REGIONAL AFFAIRS (CURA)

Thomas M. Scott, Director, 330 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 625-1551.

The regents established the Center for Urban and Regional Affairs to help make the University more responsive to the needs of the larger community and to increase the constructive interaction between faculty and students, on the one hand, and between the University and those dealing directly with major public problems, on the other hand.

The specific projects of the center are selected from several broad problem areas reflecting major concerns in this region: housing, human relations, environment, energy, transportation, land use management, local government organization, and the diffusion of information about these topics. These problems cut across a wide and changing array of disciplines.

CURA's role is to help coordinate and stimulate projects in these problem areas. It works with the faculty and students of all academic units of the University. All CURA programs are pilot, experimental, or short term projects. The goal is to probe and evaluate, complete short-term projects, discard unsuccessful ones, and help build successful ones into the appropriate part of the academic structure. CURA does not have a permanent faculty or research staff and does not offer degrees. It confines itself to projects for which there is currently no other practical administrative home.

The center also publishes a newsletter, the *CURA Reporter*. Information about both the newsletter and the center may be obtained from the CURA office.

DEPARTMENT OF PROFESSIONAL DEVELOPMENT AND CONFERENCE SERVICES

Steven Weiland, Director, 215 Nolte Center for Continuing Education, 315 Pillsbury Drive S.E., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 625-8040.

The Department of Professional Development and Conference Services, with support from the University of Minnesota academic faculty, assists groups in developing and presenting continuing education programs.

The department has a professional staff to assist interested parties in planning, publicizing, administration, and evaluation of continuing education programs.

Continuing Education in Public Policy occasionally sponsors programs for the general public in the field of environment, urban problems, and planning. For further information contact the director.

GRAY FRESHWATER BIOLOGICAL INSTITUTE

Richard S. Hanson, Director, P.O. Box 100, County Roads 15 and 19, Navarre, Minnesota 55392; phone (612) 471-8476.

The Gray Freshwater Biological Institute is a multidisciplinary unit drawing faculty members from biochemistry, botany, and microbiology. The institute, administered by the College of Biological Sciences, has two major responsibilities: to conduct fundamental research on freshwater related systems and to train undergraduate, graduate, postdoctoral students drawn from the various disciplines. The institute's core program emphasizes modern techniques of microbiology, biochemistry, molecular biology and molecular spectroscopy.

LIMNOLOGICAL RESEARCH CENTER

Herbert Wright, Director, 220 Pillsbury Hall, 310 Pillsbury Drive S.E., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 624-7005.

This center conducts research on the physical, chemical, biological, and geological aspects of lakes, especially those in Minnesota. Studies of lake history are made through analyses of microfossils and of the chemical and mineral components of sediments.

An evening seminar on current problems in limnological research is presented every winter quarter. Courses and degree programs in limnology are coordinated primarily through the departments of Geology and Ecology and Behavioral Biology.

MINNESOTA GEOLOGICAL SURVEY

Priscilla Grew, Director, 2642 University Avenue, St. Paul, Minnesota 55114; phone (612) 627-4780.

The Minnesota Geological Survey is engaged in a number of activities related to the environment and planning. These include developing a data base of waterwell logs and groundwater data for the state of Minnesota; compiling subsurface engineering geological maps for siting major structures and developing underground systems; studying the geological environment of Minnesota's peat resources in connection with the state's peat inventory program; and preparing for selected county atlases containing geological, hydrogeological, physiographic, resource, land suitability data useful for environmental planning and management.

Students are employed by the survey as aides and research assistants. Whenever possible their work forms part of the research for a master's thesis or PhD dissertation. Thus the Minnesota Geological Survey is a potential source of employment and research support in geologically related aspects of the environment and planning.

The Minnesota Geological Survey maintains a complete inventory of topographic and geologic maps of the state, as well as publications on the state's geology and resources. For further information, contact the director.

MINNESOTA PUBLIC INTEREST RESEARCH GROUP (MPIRG)

Kristan Blake, Executive Director, 2412 University Avenue S.E., Minneapolis, Minnesota 55414 (campus office in Coffman Union, Minneapolis Campus); phone (612) 627-4035.

MPIRG is a nonprofit, nonpartisan organization representing Minnesota college students and working for constructive social change to benefit all Minnesotans. MPIRG activities focus on such issues as environmental protection, consumer protection, health care delivery, housing, human rights, occupational safety, and similar matters in the public interest.

MPIRG is funded by nearly 55,000 students on nine Minnesota college and university campuses who pay a special fee for its support.

MPIRG is directed by a board of elected student representatives from the participating institutions. The board holds open meetings at least once a month. All matters of organizational business—from hiring staff, to allocating $200,000 annual budget, to selecting projects for the organization—are handled by the board. Any enrolled, fee-paying student may seek election to the board. Annual elections are held in the spring.

MPIRG employs a full-time staff of fourteen people including attorneys, researchers, organizers and support staff.

MPIRG publishes a monthly newspaper, the *Statewatch*. MPIRG sponsors coursework on advocacy—on campus, in communities, and with the legislature. It also provides numerous internships.

After careful investigation of selected problem areas, the MPIRG professional staff members and student participants work together in coordinated programs that involve publication of research findings and recommendations for public action, active representation before government administrative and regulatory agencies, law reform through legislative action, and, where necessary, legal action through courts.

OFFICE FOR SPECIAL LEARNING OPPORTUNITIES (OSLO)

220 Johnston Hall, 101 Pleasant Street S.E., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 624-7577.

Independent study and field learning assistance.

PHYSICAL PLANT ENVIRONMENT ENGINEERING

Robert A. Sivagni, Environmental Engineer, Physical Plant Operations, 200 Shops Building, 319 15th Avenue S.E., Minneapolis, Minnesota 55455; phone (612) 625-8306.

The University Physical Plant, which maintains facilities equivalent to those of a major Minnesota city, provides an opportunity for students to investigate practical environmental engineering problems and principles. All possible support is given to students who wish to explore the application of environmentally related innovations at the University. Credit may be earned for worthy projects of sufficient difficulty when arranged through appropriate departments. These projects include studies and "hands-on" field work in the areas of solid waste management, air pollution control, waste water treatment, chemical waste treatment, and waste recycling.

ST. ANTHONY FALLS HYDRAULIC LABORATORY

Heinz Stefan, Associate Director, Mississippi River at 3rd Avenue S.E., Minneapolis, Minnesota 55414; phone (612) 627-4010.

The St. Anthony Falls Hydraulic Laboratory conducts research on the flow of water in streams, rivers, estuaries, lakes, and man-made pipes, channels, and reservoirs. Transport of sediment, heat, and dissolved substances as well as natural and artificial water storage, drainage, runoff, and other hydrological processes are part of the research program.

In its 45-year history the laboratory staff, comprised of Civil and Mineral Engineering Department faculty, civil service employees, and graduate and undergraduate students, has conducted hundreds of studies on water-related projects locally, nationally, and internationally. Extensive documentation is available through reports and films of the research studies in the Lorenz G. Straub Memorial Library.

The laboratory provides academic and financial assistance to graduate and undergraduate students interested in water resources engineering and related programs.

UNDERGROUND SPACE CENTER

Raymond L. Sterling, Director, 790 Civil and Mineral Engineering Building, 500 Pillsbury Drive S.E., University of Minnesota, Minneapolis, Minnesota 55455; phone (612) 624-0066.

The Underground Space Center is a division of the Department of Civil and Mineral Engineering. The center was founded in November 1977 by the Minnesota Legislature in response to the growing interest in many aspects of underground space utilization.

The goals of the center are to: serve as a focal point for planning and coordination of underground space use; carry out research in areas affecting underground space use; provide an information and referral service for all aspects of underground space utilization, and serve as a focal point for international cooperation or research and information transfer.

One of the major activities of the center is conducting research and providing information on earth-sheltered housing; the first report from the center was a book of guidelines for the design of such houses. Further information and a number of publications (including the guidelines) are available from the center.

The Underground Space Center offers two courses on earth-sheltered building design and underground contruction engineering; these courses are listed under the Civil Engineering Department's fall and winter class schedule. Energy use, planning, security, environment, building design, landscaping, building codes, financing and psychological considerations are topics, studies and discussions in these courses.

WATER RESOURCES RESEARCH CENTER

Patrick Brezonik, Director, 866 Biological Sciences Center, 1445 Gortner Avenue, St. Paul, Minnesota 55108; phone (612) 624-9282.

The Water Resources Research Center was established in the Graduate School in 1964. The center has responsibility for stimulating water resources research at the University of Minnesota and at state and private colleges through administration of funds associated with the Federal Water Resources Research Act of 1964; coordinating the research with programs of local, state, and federal agencies and private organizations throughout the state; and assisting in training additional scientists for work in the field of water resources through research. The following state and private colleges participate or have participated in the center's programs: St. Mary's College, St. Cloud State University, Gustavus Adolphus College, Bemidji

State University, Winona State University, Mankato State University, and Concordia College.

The center does not conduct research, nor does it have research facilities. The center supports water resource research activities of departments and schools and assists in expanding interdisciplinary research. It plans and arranges for divisions of the University of Minnesota and state universities and private colleges to conduct competent research of either a basic or practical nature in relation to the physical-biological-economic-social-political aspects of water resources.

One of the purposes of the center is to stimulate and review educational offerings that will prepare students for careers in the field of water resources. The center assists in recruiting students and in guiding them into appropriate programs of study. The center has been helpful to the University in developing many new courses in the area of water resources, a new graduate option in hydrology, and a graduate program in water resources.

The center publishes and distributes quarterly newsletters and information circulars to people thoughout the state. Research projects generate many technical reports and theses. Upon request, the center distributes copies of its publications to people throughout the state and nation. To provide an opportunity for professional people and students working in the field of water resources to meet and exchange information, the center also sponsors interdisciplinary seminars and short courses.

LIBRARIES

UNIVERSITY LIBRARIES-TWIN CITIES

The research collections that support the courses and programs in the environment are found throughout the 19 libraries which comprise the University Libraries. The six major library units and their respective environmentally-related collections are:

Bio-Medical Library/East Bank (Diehl Hall)

Contains environmentally-related materials in the fields of health sciences, including microbiology, pharmacology, environmental health, and genetics.

Humanities and Social Sciences/East Bank (Walter Library)

Contains environmentally-related collections in education, sport, recreation and psychology.

Humanities and Social Sciences/West Bank (Wilson Library)

Contains environmentally-related collections in a broad range of social sciences and humanities, including economics, political science, sociology, anthropology, philosophy, and history. The MAP LIBRARY and the BUSINESS REFERENCE SERVICE are also located in Wilson. The GOVERNMENT PUBLICATIONS LIBRARY (409 Wilson Library) serves as the official U.S. Regional Depository for the State of Minnesota. It houses all federal depository documents and also has holdings of non-depository federal, municipal, and regional documents, with emphasis on the Twin Cities area.

Law Library/West Bank (Law Building)

Contains environmental law materials.

St. Paul Libraries/St. Paul Campus

Besides the St. Paul Central Library (with its collections on agriculture and home economics), five libraries on the St. Paul Campus contain environmentally-related material in the fields of biochemistry, forestry, wildlife, vegetation, and veterinary medicine. These libraries are:

Biochemistry Library	(406 Biological Sciences Center)
Entomology, Fisheries and Wildlife Library	(375 Hodson Hall)
Forestry Library	(203 Green Hall)
Plant Pathology Library	(395 Borlaug Hall)
Veterinary Medical Library	(450 Veterinary Science)

Science and Technology Library/East Bank (Walter Library)

Collections on chemistry, engineering, geology, mines and metallurgy, and physics contain environmentally-related information ranging from urban design to water pollution to environmental geology. There is a separate ARCHITECTURE LIBRARY (160 Architecture).

In addition to strong collections, the University Libraries offer a full range of reference and research services including specialized reference assistance and computerized data base literature searching. Inquire at any library.

NON-UNIVERSITY LIBRARIES

Environmental Conservation Library (ECOL)

Minneapolis Public Library, 300 Nicollet Mall, Minneapolis, Minnesota 55401; phone 372-6570.

ECOL, a special collection within the Minneapolis Public Library, brings together materials from various subject fields that relate to the physical, environmental and human impact on it. ECOL has books, periodicals, newsletters, pamphlets, bibliographies, posters, and government documents relating to such topics as air and water pollution, solid waste, wildlife, conservation of natural resources, land use planning, environmental law, energy resources, and environmental education. ECOL was designated by the Minnesota Legislature as a state center for environmental information and receives publications of many state agencies, including environmental impact statements. ECOL serves as the local public document room for U.S. Nuclear Regulatory Commission materials relating to nuclear power plants in Minnesota. A newsletter, *ECOL News*, is published twice a year and is free to the public.

Two large collections of full documents and articles on microfiche are available for use and loan. Entitled Envirofiche and Energyfiche, they are keyed to the abstract journals *Environment Abstracts* and *Energy Information Abstracts*.

Minnesota Department of Health Library

717 Delaware Street S.E., Minneapolis, Minnesota 55440; phone 623-5090.

This collection has been developed with the needs of public health professionals in mind and is a specialized library with technical, as opposed to popular, literature. It is a reference collection only and extends no loan privileges except through interlibrary loan. The library subscribes to some 200 periodicals. Hours are 8:00-4:30, M-F. A photocopy machine is available.

Minnesota Department of Trade and Economic Development Library
(Formerly Minnesota Energy and Econimc Development Library)

900 American Center Building, 150 East Kellogg Boulevard, St. Paul, Minnesota 55101; phone (612) 296-8902.

This research library has a noncirculating collection, although some items may be borrowed through the MINITEX system. The collection contains United States and Minnesota statistics of energy use, Department of Energy reports, and approximately 200 periodicals. There is strong emphasis on energy conservation reports. The library has environmental information on coal development, electric power, nuclear power, and solar energy.

The library also has a collection on economic development issues including trade, high technology, location of industry, and business conditions with materials discussing Minnesota, other states, and U.S. conditions.

Minnesota Pollution Control Agency Library

520 Lafayette Road, St. Paul, Minnesota 55155; phone 296-7719.

This collection has been developed with the needs of professional pollution control engineers in mind. Therefore, it is essentially a technical library with few subprofessional materials. The library extends reference services.